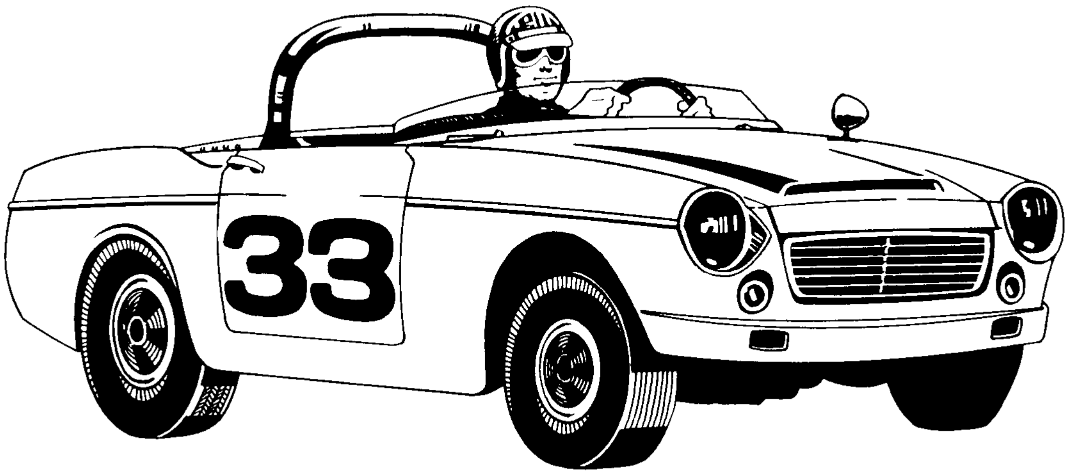
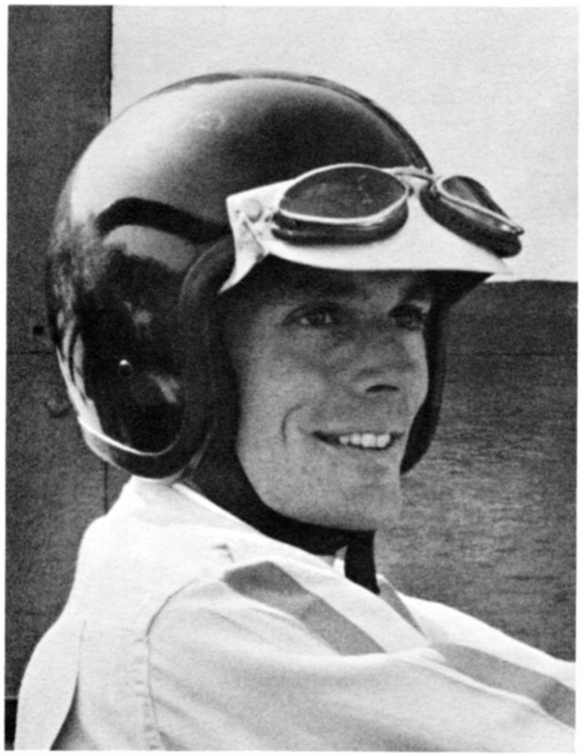


DATSUN COMPETITION PREPARATION MANUAL

Prepared by
BOB SHARP RACING
117 Danbury Road
Wilton, Connecticut

In cooperation with
NISSAN MOTOR CORP. IN U.S.A.
137 E. Alondra Blvd.
Gardena, California

INTRODUCTION



The Nissan Corporation of Japan is producing the finest production sports car, in its price range, available anywhere today.

Whether you want to buy any of their models for just everyday driving or full competition work you get the most car for your money — and, a tough, dependable machine.

The Bob Sharp Racing Organization selected Datsuns three years ago as the car that had the best chance of winning its class in sports car racing for the least grief and cash outlay. And these are very important considerations for anybody selecting a car for "just transportation" or serious racing.

During the period we have campaigned our Datsuns, a 1500 and 1600 cc model running in classes G and F, a great deal has been learned and definite improvements made in both engine and chassis. As with all racing cars, these changes and improvements came slowly through trial and error with many disappointing results along the way. But, things work out and we now have two race cars that can go against anything in their class.

The purpose of this manual is to pass along our experiences on developing and campaigning the two models of the Datsun sports car, and to eliminate, for you, some of the problems and errors we encountered.

You'll notice this booklet is in loose-leaf form. The purpose being that as time passes, and we find new and better ways of getting desired results, we will mail them along to you in the form of replacement or additional pages. This will keep your manual up to date and your car competitive no matter what the other guys come up with during the season.

Our goal is to see more Datsuns in competition on drag strips, at hill climbs, speed and time trials and on sports car tracks.

With a manual such as this, **plus** the optional equipment and parts that are now readily available to everyone, Datsuns will dominate.

Bob Sharp

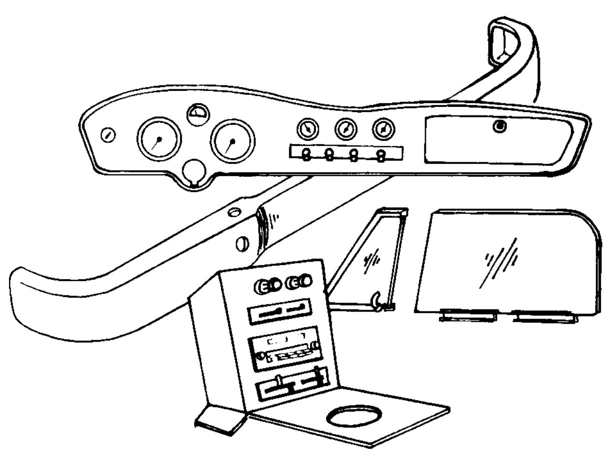
Bob Sharp
Bob Sharp Racing

CONVERTING FROM STREET TO TRACK

TABLE OF CONTENTS

CHAPTER I—GENERAL

This manual will deal with various stages of modifications that can be made to the 1500 (SPL 310) and 1600 (SPL 311) models of the Datsun sports car. In many of the discussions, the most extreme changes desired for full competition work will be given. In other cases, recommended changes will be discussed in stages that are best suited for various activities ranging from rallye and gymkhana to all-out racing. In all instances, the most economical approach will be considered and, for your convenience, a general price list has been incorporated at the end of the manual so that you might keep a running account of just how far you can go from your wallet's point of view.

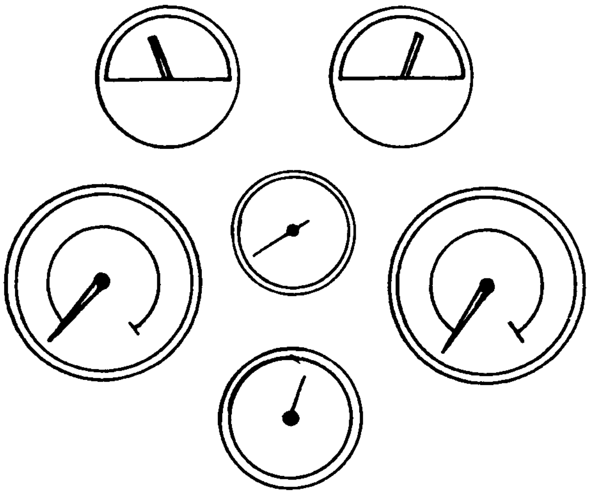


STRIPPING FOR WEIGHT REDUCTION

For full competition, or any part thereof, one of the quickest ways of going faster is to remove weight. Just to give you an idea of how important this is, on the 1500 model (Class G) every 19 pounds removed gives you one horse. So, a systematic removal of weight is a pretty cheap way of going faster. (You. might even consider knocking off that extra drink or desert with dinner as part of the game also.) On the 1600 model (Class F), it's 17 pounds per horsepower. These figures are based on a full competition engine sitting in a stock body. Under the present SCCA rules, the maximum allowable weight reduction is 5% of the manufacturer's listed shipping poundage as it appears in the Club's "Production Car Specifications" booklet.

INTERIOR MODIFICATIONS

For full competition, it is recommended that the center console be removed for safety and driver comfort — as well as the heater, tunnel and floor mats, door glass and window-winding mechanism. If you're really ambitious, you might wish to redesign the dash instruments' layout for better reading. A home-made dash board of aluminum also cuts about 10 pounds from the stock unit and is easily installed as the original piece drops out by loosening a few bolts. It's a good idea to solder all ignition wires to the terminals on the key/starter as they have a tendency to vibrate loose at the most embarrassing times.



INSTRUMENTS

A little care is in order here. When using the heavy duty oil pump (Part No. 15010-12210), replace the oil pressure gauge with a good, full-sweep instrument with a direct pressure line into the engine block. The stock unit is electrical and only reads to 90 PSI and is prone to give false readings. Purchase a gauge with a high reading of 150 PSI as the heavy duty oil pump puts out a little over a 100 pound reading when the engine is cold. Your new gauge will come with tubing and female fittings, but it will be necessary to order, from your Datsun dealer, a special male brass fitting (Part No. 22954-10400) to replace the electrical sending unit in the side of the block.

Purchase an oil temperature gauge if the optional aluminum sump and oil cooler are not installed. An operating temperature up to 230° is ok. If, because of climatic conditions in your area, your engine runs over 230°, invest in the oil cooler (Part No. 21300-12210) and larger aluminum sump. Order the 1600 model sump (Part No. 11110-14610) — it fits the 1500 block too.

The alternator and fuel gauges are ok as is, but a water temperature gauge, of the full-swing 240° type, should replace the stock unit.

It is also recommended that a mechanical tachometer, with a top reading of at least 8,000 be installed. The stock unit reads only to 7,000 and a well prepared Datsun 1500 engine will turn 7,300 RPM and the 1600 model 7,800 RPM — all day. The Jones Motrola tach has proven most reliable and by-passes any electrical problems sometimes incurred with battery-assisted set-ups. Also, on the Jones unit, the needle follows the engine very closely with no lag or over-run. And, it carries a resetable "tell tale" needle to keep you honest.

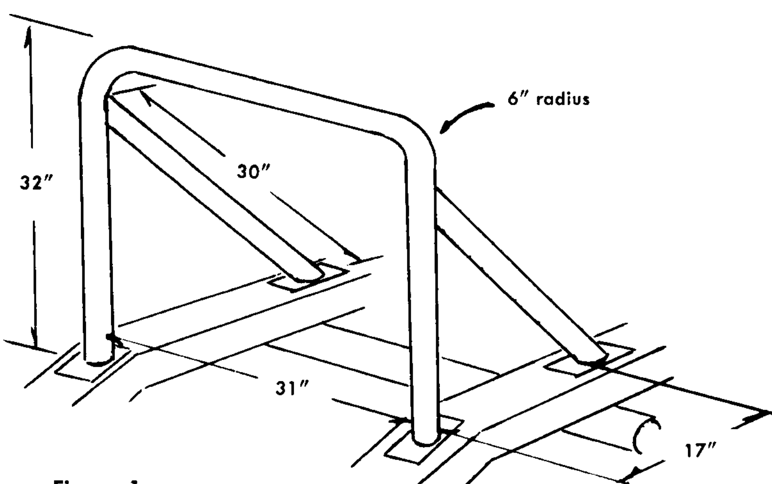


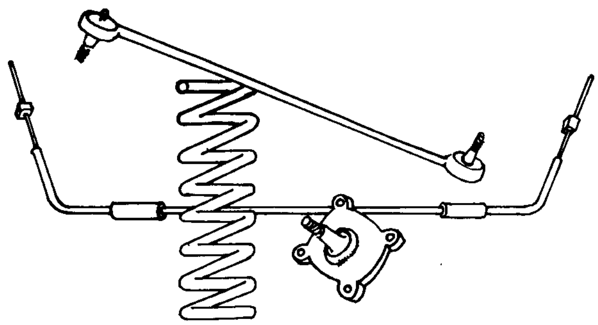
Figure 1

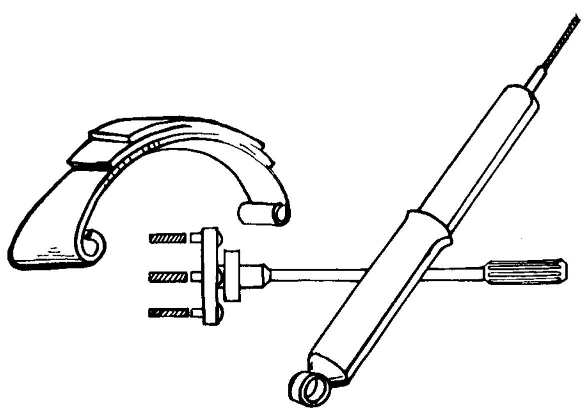
Typical roll bar dimensions for easy installation in the 1500 and 1600 models of the Datsun.

ROLL BAR

Installation of this handy item is quite easy in the Datsun. The frame is so positioned that direct contact can be made through the "shelf" behind the seats without a lot of fancy bends. You must use at least 1½" outside diameter x .120" wall thickness material with ⅜" diameter bolts of SAE quality. Check your SCCA "General Competition Rules" for additional details. Figure 1 shows the set-up on the Bob Sharp cars using 2" OD material.

CHAPTER II—SUSPENSION & BRAKES





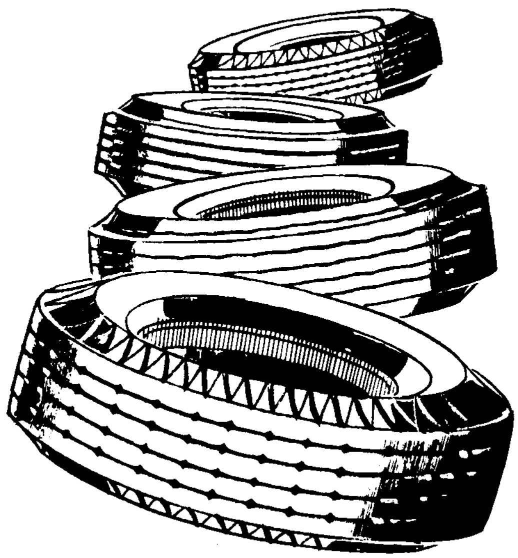
Whether your car is new or used, magnafluxing is a must. Check the front hubs, spindles, discs, wheels, spindle nuts, disc calipers, brackets, rear axles, brake drums, ball joint nuts, steering arm and its bolts, etc.

WHEELS & TIRES

American Racing Wheel and Minilite Magnesium Wheel Companies offer 13" and 14" wheels for all models of the Datsun sports car. On the 1500 model, a 5½" rim width is allowed; on the 1600 and 2000 models, use the 6"x14" wheel. It is strongly recommended that these wheels be used for full competition as the stock steel wheel flexes too much under side loads and has a tendency to crack around the hub contact area. When fitting the mag wheel to the front hub, check carefully to ensure that the inside of the spokes are not touching the disc brake caliper. If they are, the edge of the caliper may be filed or ground to clear. Also check the clearances of the steel brake lines on the caliper. They may touch the inside rim of the mag wheel if left in their normal factory installed position.

As on most production sports cars converted to full competition, tire sizes and clearances can be quite critical. With the advent of the "low profile" racing tires being produced by Goodyear and Firestone, the Datsun can now be lowered more, but inside fender well clearances have to be considered because of the increased width of these tires.

On the 1500 model, use the 5.00/8.30 x 13" or the 5.50/8.00 x 13" depending on your gearing and type of competition. In both cases it will be necessary to bend or grind the rear frame lip (portion over the rear axle) to ensure adequate tire side wall clearance. The box frame has a welded seam in this area and it might be necessary to re-weld the edge after grinding. Also grind the edge of the rear spring where it would make contact with the tire's side wall, and roll-over the inside of the outer fender lip. Note carefully the clearance of the tire to the inner fender well. In most cases this sheet metal must also be removed or pushed in. Up front, roll-over the fender lip and check the lock-to-lock steering positions for tire rub.



Because of the increase of wheel diameter from 13″ to 14″ on the 1600 and 2000 models, tire clearance is even more critical. If a tire such as a 5.75/9.50 x 14″ is used, the car cannot be lowered without encountering tire contact to all parts or the fender well. However, the newer, low profile tires now available allow the car to be lowered as much as 1 ¼″ and give far greater handling characteristics. For instance, a 5.00/8.30 x 14″ (diameter, 24″; cross section, 8.3″; tread width, 6.3″) allows the car to be lowered from 1″ to 1 ¼″—depending on the rear spring rate. If a 5.50/9.20 x 14″ (diameter, 25″; cross section, 9.2″; tread width, 7.0″) is fitted, the car can only be lowered ¾″ to 1″. In either case, the same fender well area modifications, as recommended for the 1500 model, must be made. In addition, a 1/16″ wheel spacer might be employed to center the tire in the fender well more evenly. This would be especially true when using the 5.50 or 5.75 series tires. For added insurance, you might consider installing a transverse, rear-end locating (Panhard) rod.

If you're not interested in all these modifications, or feel it's not worthwhile for the type of competition you'll be entering, run a 6.00 x 14″ on your steel wheels and check the clearances all around. You might also consider using an American compact car steel wheel which has the same lug bolt pattern as the Datsun (Corvair, Buick Special) in order to gain a wider rim width and utilize as much rubber on the ground as possible.

We'll leave the tire pressures up to you. Everything from 30-48 lbs. seems to work —depending on the track conditions, suspension settings and individual driver preference.

1500 FRONT SUSPENSION

For full, or serious, competition, lower the car 1". This can be accomplished by collapsing one coil of the front stock spring. Remove it from the car and put a torch to the top coil. When it's hot enough, compress the coil until it touches the second coil. Let it cool naturally. This should give you the desired car height, but a little trial and error might be in order as springs and cars differ slightly.

Bob Sharp Racing has developed a shock absorber that is inexpensive and works very well. These, or Koni Shocks, are recommended as replacement units for any type of active driving.

The front rubber bumbers, located on the lower "A" arms, should be cut to give more travel to the suspension. How they are cut — the angle, and/or the height, determines greatly the handling of the car. Here again, it is highly recommended that work in this area be undertaken whether you intend to race seriously or just make a few autocrosses at the local shopping center. Generally, remove approximately ¾" of rubber from the peak of the bumper if the rest of the suspension is to be in stock form, or 1 ¾" if the front springs have been collapsed to lower the car one inch. Figure 2 illustrates the extreme modifications that can be made to induce over and understeer.

A stiffer front sway bar should be fitted. This may be purchased from Bob Sharp Racing or fabricated out of ⅞" chrome moly stock — utilizing the stock mounting points and brackets.

The front-end settings on the 1500 can be modified by shimming the upper "A" arms. Set the camber at 1½°-2½° negative, leave the caster factory set at 1½° positive, and toe-in the steering ⅛".

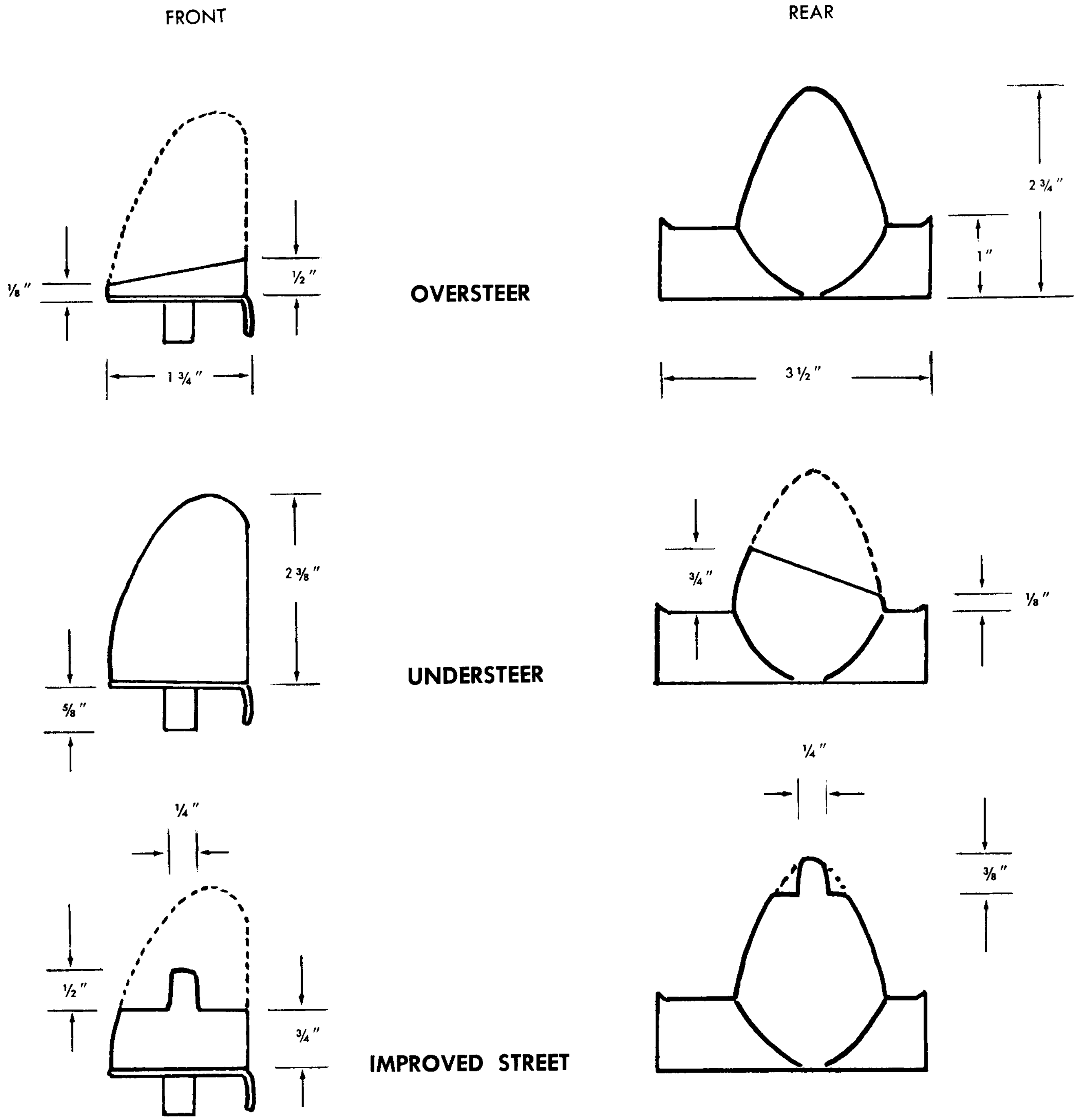


Figure 2

Modifications to the rubber bumpers on all models of the Datsun can be easily made by bench grinding or cutting with a hacksaw.

1500 REAR SUSPENSION

The rear rubber bumpers should be modified as discussed above for the front bumpers with the following exception: on a tight, twisty course (as in gymkhana work or race tracks like Marlboro) the rear bumpers should be a little longer than the fronts. Suspension tuning comes into play here and will vary according to driver needs, road surface and tightness of corners. The general rule is: the longer the rear rubber bumper, the quicker the frame will make contact and cause oversteer. And, conversely, long rubber bumpers in the front will cause understeer and plowing. So if you want the rear end to come around a little more (induced oversteer), cut the fronts and leave the rears stock.

The above modifications to rubber bumpers are the easiest and least expensive way of tuning suspensions. But, the better and more accepted way of modifying is to work with rear spring rates. Bear in mind, a stiffer rear spring is ok **if** a limited slip is fitted. The reason being, a stiffer spring will lift the inside wheel quicker in a tight turn; a stock spring allows the inside wheel to hang down a little longer — giving more bite. In conjunction with this, a heavy duty sway bar in the front reduces body roll and helps keep the inside rear wheel on the ground. So, with a limited slip installed, you'll have equal success in suspension tuning if you play with the rear spring rate. Any competent spring shop can work with you on these modifications. And, as mentioned above, if you don't plan to install a limited slip, stick to tuning through the rubber bumpers, heavier sway bar and the special shocks. Remember, the different combinations of car height, spring rates, larger diameter sway bar and rubber bumper modifications will alter the handling of the car from one extreme of plowing to violent oversteer. Changing each of these items is tricky work and every modification effects the other components of the suspension. If you don't wish to become involved in this type of experimentation, Bob Sharp Racing has developed the various suspension packages for every type of road condition. Or, you may communicate directly for assistance on your particular problem.

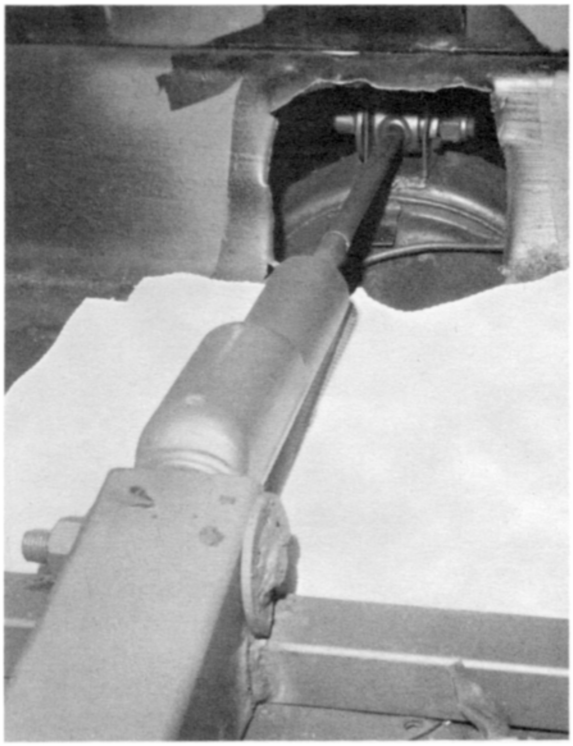


Figure 3 — Installation of a rear stabilizer bar (or torque rod) recommended for all 1500 and pre-1967 1600 models. This is a Koni unit fitted in such a way as not to limit the rear end travel, and is mounted from the top of the axle housing back into the trunk floor. This is an important item to consider in conjunction with lowering blocks as discussed on Page 2-7.

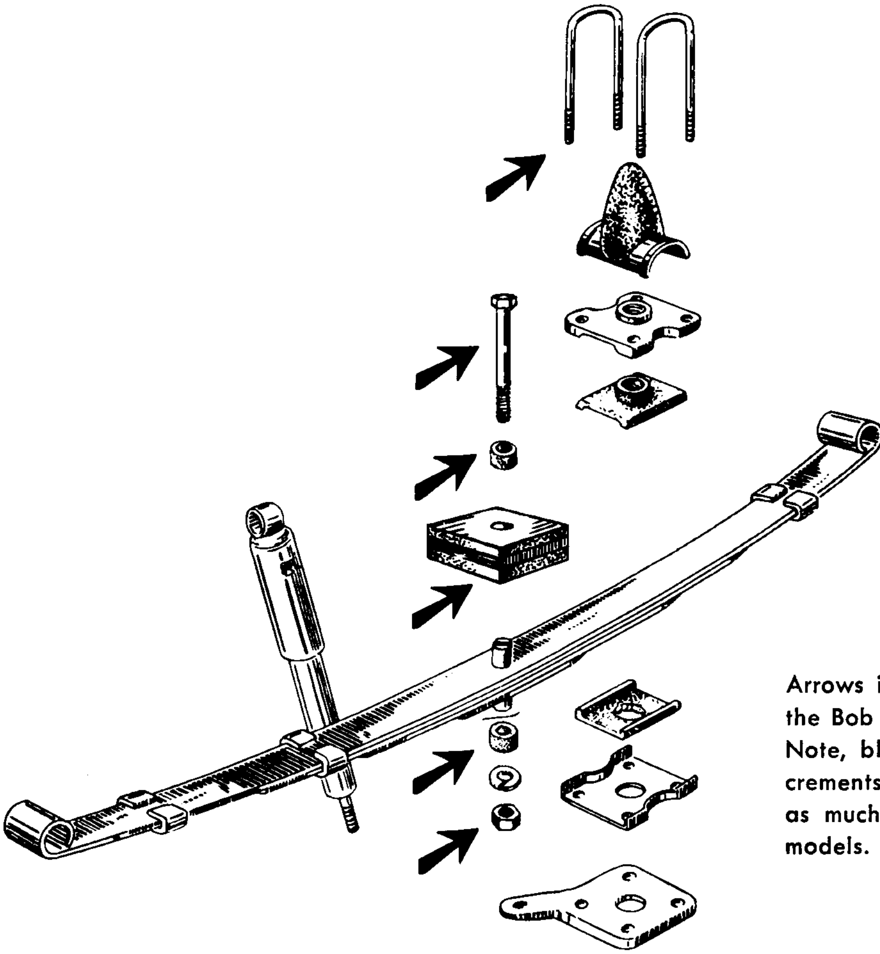
1600 & 2000 FRONT SUSPENSION

As mentioned earlier in this chapter, it is not possible to lower the 1600 or 2000 models of the Datsun if a tall tire such as a 5.75/9.50 x 14″ is used. In fact, additional front suspension modifications, such as increasing the positive angle of the caster and setting the negative camber at an extreme 4°, was necessary to secure adequate clearance. With the low profile tires, such as the 5.00/8.30 and the 5.50/9.20, it is now possible to bring the car down as much as 1¼″. Also, a more realistic negative camber setting of 1½° to 2½° can be used since the low profile tires do not flex as much and a more upright position of the tire will put more rubber on the road.

It is recommended that the same modifications as given on Page 2-3 for the 1500 front suspension should be followed on the 1600 and 2000 models. If you don't wish to modify your front springs as outlined on Page 2-3, you may purchase a competition front spring from the factory (Part No. 54010-25510). This spring is stiffer and has already been lowered the recommended one inch.

For full competition work, the rubber rebound bumpers should be cut as shown at the top of Page 2-4 to induce slight oversteer as the situation demands. You'll find this modification is necessary for proper handling — especially if you intend to install a limited slip differential. By allowing the front suspension to travel further before contacting the bumper, the rear will swing out (oversteer) and get the car around the apex of the corner in a more orthodox attitude.

Again, as with the 1500 model, a ⅞″ diameter sway bar should be installed along with stiffer shock absorbers. The caster may be left factory stock and the toe-in set at ⅛″.



Arrows indicate various parts included in the Bob Sharp Racing Lowering Block Kit. Note, blocks may be stacked in ¼″ increments — allowing car to be lowered as much as 1¼″. Recommended for all models.

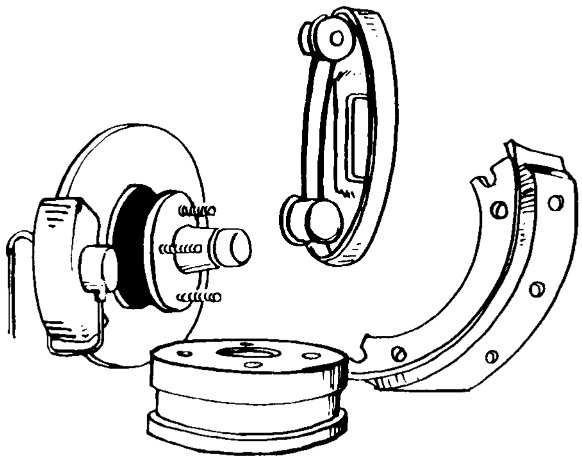
1600 & 2000 REAR SUSPENSION

Until 1968, the legality of using lowering block on the rear suspension was very questionable in SCCA sanctioned events. Now, this item is an open option and very definitely should be employed. It is the easiest and least expensive way of getting the rear of the car closer to the ground. Bob Sharp Racing has developed a lowering block kit that allows the car to be lowered in ¼″ increments. With the low profile tires mentioned earlier, the rear should be lowered 1″ to conform to the front suspension recommendations given on Page 2-6 for full competition work.

As a point of interest, the Nissan Corporation began installing softer rear springs in the 1967 models of the 1600 (from engine #R-4000) and all of the 2000's imported into the U.S. At the same time, a competition rear spring (Part No. 55020-25510) was introduced for racing. Testing of this spring on the Bob Sharp Racing cars, with the aforementioned front suspension recommendations, proved it to be a little too stiff for the type of road courses encountered in this country. Therefore, if you have the later model of the 1600, or a 2000, you might wish to install the earlier model 1600 spring (Part No. 55020-10500). Or, you may use the factory competition spring and remove the two smallest leafs in order to soften the rate.

On any spring you use, it is advisable to have them re-bracketed to keep the leafs tight. Any spring shop can do this work.

The rubber rebound bumpers should be modified as recommended on Page 2-5 for the 1500 model.



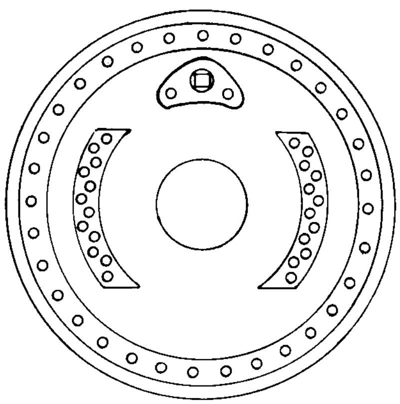


Figure 4 — 1500 & 1600 model brake backing plates drilled ⅜″ to allow additional cooling.

1500 BRAKES

This model has 9″ drums on all four wheels. A good sintered metallic lining should be installed. Also, micro-polish the drum-to-lining surface for smooth contact. The brake linings can be purchased from a Velva-Touch franchisee located in most major cities. Be sure the linings are riveted as well as bonded. If you can't find a source for this type of lining material, Bob Sharp Racing has it available on a shoe exchange basis. The front and rear backing plates should be drilled with ⅜″ holes as shown in Figure 4.

It is recommended that a good lithium-based moly EP grease be used on wheel bearings in both models of the Datsun as brake heat has a tendency to melt material of lesser quality.

A neat little mod is to install the 1600 model hydraulic brake and clutch reservoirs on the 1500 model. They're bigger and increase the capacity of the fluid in the system.

1600 & 2000 BRAKES

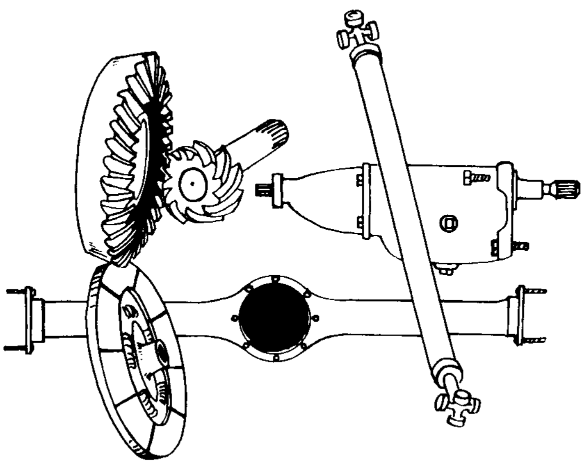
As on the 1500, drill the rear backing plates for additional cooling. On the front discs, bend the dust shields inward to a 45° angle to scoop more air into the disc and caliper.

For racing, there are two front pad/rear lining combinations to be considered. The Raybestos metallic pad may be used in conjunction with the Velva-Touch sintered metallic rear linings discussed above. This combination is adequate in stopping-power and longevity. However, on the 2000 model, with its greater top speeds, a different material might be in order. The Ferodo DS-11 type pad has proven to have greater stopping-power with slightly less longevity. This pad must not be used with the Velva-Touch rear lining because the different frictional coeffitients of the two materials does not allow the rear linings to perform fully. With this pad, use Ferodo's rear lining material listed only as "Special Performance" lining. All brake materials are available through Bob Sharp Racing.

The finned aluminum rear drums that come as standard equipment on the 2000 model may also be fitted to the 1600. They reduce unsprung weight and aid greatly in cooling the brake linings.

On all models, it is recommended that a 550° boiling point brake fluid be used in the system.

CHAPTER III—DRIVE TRAIN



1500 & 1600 CLUTCHES

The stock 1500 and 1600 clutch discs will not hold up too well under full competition use. It is advisable to replace the stock material with a brass impregnated fabric lining such as the Rusco Company produces, and have the disc balanced. Or, either model, already modified, can be purchased through Bob Sharp Racing.

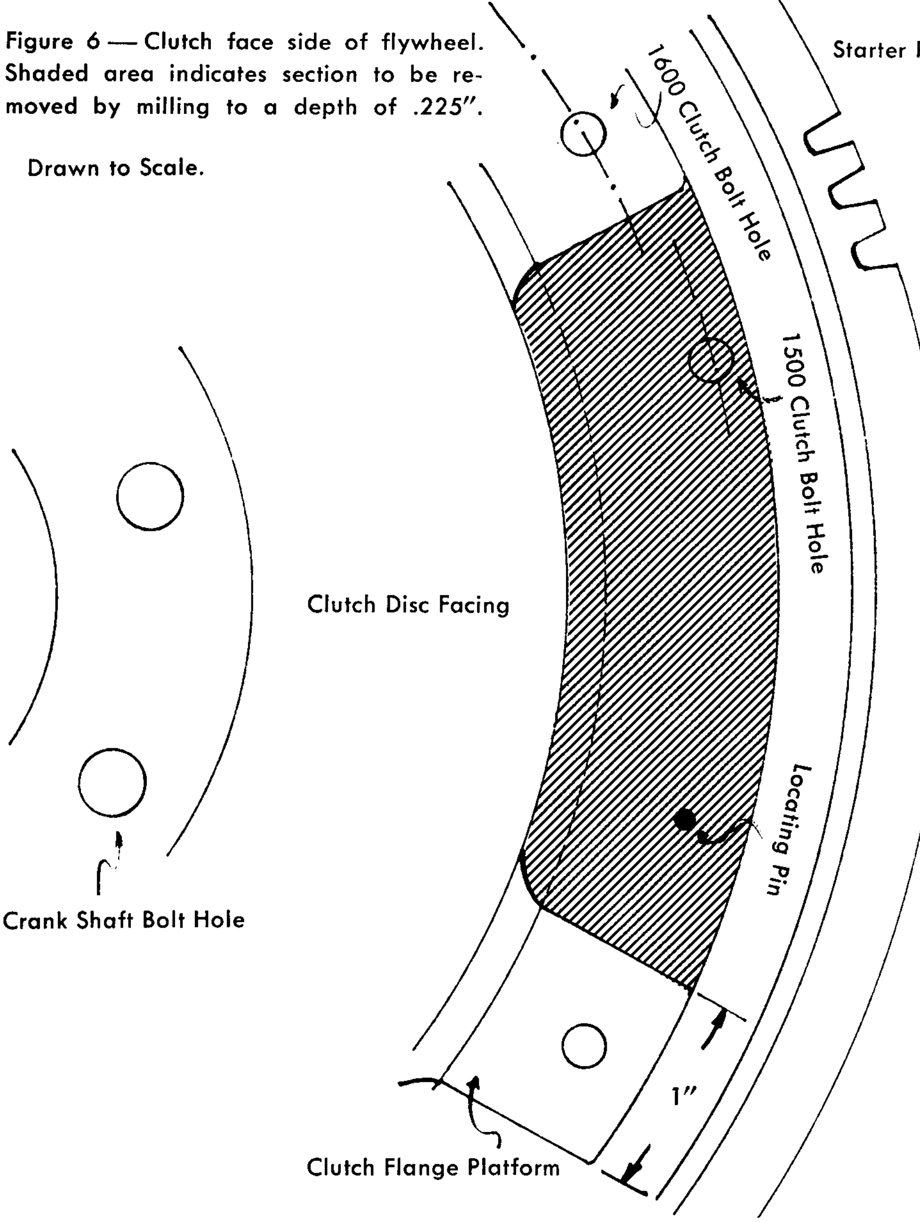
The 1500 clutch has to be beefed-up for competition use. Replace the clutch springs with stronger units available from any brake and clutch repair shop. You're looking for a total increase in spring pressure of 120 lbs. An alternate route is to use a stock 1600 clutch. This unit is fine, as is, for any type of competition. And, it fits the 1500 flywheel with only one modification: The clutch attachment bolt pattern on the 1500 flywheel is larger, in diameter, than the 1600. So, if you use a 1600 clutch, with a 1500 flywheel, have new bolt holes drilled and tapped, and new locating pins pressed into the flywheel. Figure 6 indicates, for comparison, both bolt hole patterns.

2000 CLUTCH

The stock 2000 clutch pressure plate is completely adequate for racing—even with the increased torque of the two litre engine. But, since it does carry more spring pressure than the 1600, and should you encounter any problems with the stock 1600 unit, it may be installed in the SPL-311. There is a competition pressure plate available from the factory (Part No. 30210-20110), but it shouldn't be needed with the present horsepower that is being produced. Again, as with the 1500 and 1600, the clutch disc should be replaced with a competition unit.

Figure 6 — Clutch face side of flywheel. Shaded area indicates section to be removed by milling to a depth of .225″.

Drawn to Scale.



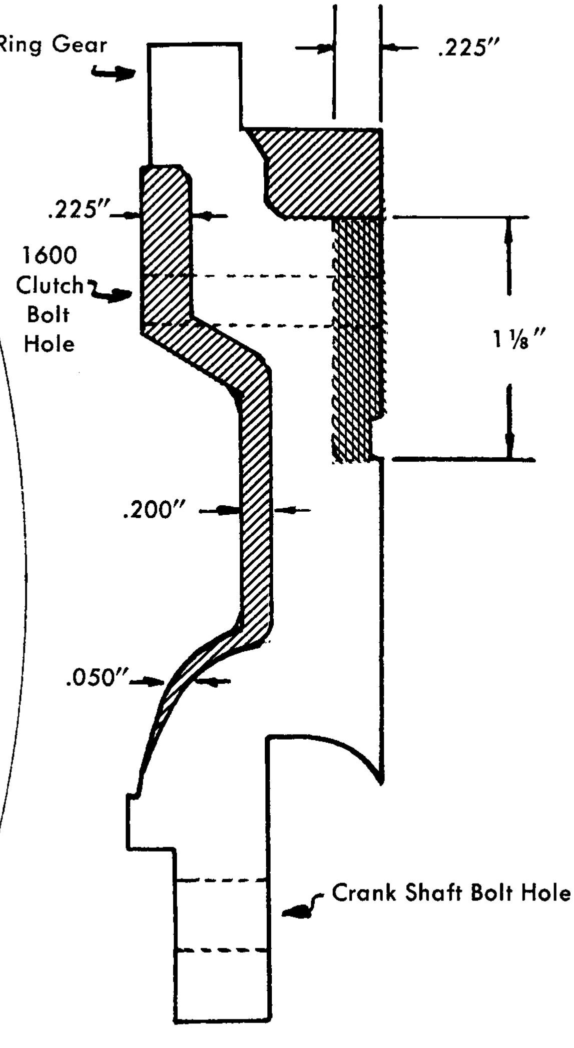


Figure 5 — Cross section of Datsun 1600 flywheel. Shaded area indicates metal removed to lighten unit to 13 lbs.

1500 & 1600 FLYWHEELS

For serious competition, have the flywheel lightened to 13 lbs. Following the contour on the back of the flywheel, remove the rough casting to a depth of .200″. Remove additional metal on the back, at the outer edge, next to the ring gear, to a depth of .225″. On the face side, from ⅜″ outside the center line of the clutch attachment bolt holes, a great deal of metal can be removed safely. The shaded area in Figure 5 indicates where to cut. The dotted shaded area is discussed next.

Figure 6, showing the face side of the flywheel, indicates the area to be scalloped between the clutch attachment bolt holes. This is a milling operation that can be performed by any machine shop. When this work is done, however, it is necessary to have new locating pins pressed into the flywheel to assist in centering the clutch when it is attached.

Bear in mind, Figure 6 is a scale drawing of the 1600 model flywheel. If you are working with the 1500 model, notice that the clutch attachment bolt hole pattern has a ⅜″ larger bolt circle diameter. Therefore, you will not be able to scallop, or mill, as far in from the outer edge. The main thing to consider is leaving a big enough "platform" for the clutch attaching flanges to rest on. As long as there is approximately a square inch of "platform" around the bolt hole, you're home free.

Radius the edges of the angles in the cut areas as it will enhance the strength of the section and insure that it doesn't end up in your lap.

1500 TRANSMISSION

Working from the transmission to the rear, the first modification to consider is close ratio gears to alleviate the "stump puller" 1st gear and long spacing between 2nd and 3rd. This condition is especially prevalent when higher numerical rear end gears are installed. The gears needed are: main drive gear, counter drive gear, main shaft second gear, main shaft third gear and the normal assortment of transmission gaskets. Use the stock 1st and reverse idler gear. If the unit you're working with is not new, it is wise to replace all the synchronizer rings. Also, pay close attention to the 2nd and 3rd gear brass bushings as they have a tendency to crack after prolonged or hard usage.

When the optical close ratio gear set is installed, it is necessary to turn down, or trim, the main shaft drive (pilot bushing end) to the same length as the stock shaft you are replacing. The close ratio main shaft is actually manufactured for a different transmission housing and this machining modification is needed to make it seat properly into the crankshaft pilot bushing.

The shifting mechanism can be made smoother by cutting one coil off the three shaft poppet springs. These are the springs that hold the check balls on each of the gear selector shafts. When this modification is performed, it has been found that the shift lever will pop out of gear after prolonged use — that is, half a full racing season. If you should experience the same problem, merely replace the poppet springs.

Safety wire the internal nuts and bolts as shown in the Datsun Shop Manual and fill the transmission with a good grade of 90 wt. gear oil to the ¾ mark on the dip stick.

On the 1500 and 1600 models, no modifications to the drive shaft are necessary unless you feel balancing the unit is the ultimate for a few extra revs.

1500 REAR END

The stock rear end ratio is 3.89 on hypoid gears. The optional gears available through your Datsun dealer are 4.11, 4.38, 4.62 and 5.13. For everyday driving and weekend autocross-type work, a 4.11 is recommended. If you don't mind sacrificing your top-end (illegal turnpike cruising speeds), you can go as low as 4.38. Keep in mind your speedometer will read low with a numerical increase in the rear end ratio. The change will be proportional — that is, a 10% change in the numerical figure in the gear ratio gives you a 10% error in the reading on the speedometer.

For racing, a 4.62 ratio works out well on most of the tracks in the country with the exception of tight, twisty courses like Marlboro and Bryar in New Hampshire. On these tracks, or other road conditions that have short straights with slow entrances, a 5.13 is recommended.

The only other modifications to the rear end would be extending the oil breather tube by some 6" to cut down on oil loss sometimes encountered with lower rear end gear ratios. If the loss is excessive, extend the tube up into the trunk — dumping into a plastic catch bottle.

1600 & 2000 TRANSMISSIONS

The standard 4-speed transmission, as delivered on the 1600, is completely adequate for racing. However, as suggested on the 1500 transmission, you may wish to re-work the shifting mechanism and check over the various bearings and bushings for wear. For full competition, use a good grade of 90 wt. gear oil and fill to one pint less than the Factory Shop Manual recommends.

The 5-speed transmission (Part No. 32010-25551) that is standard equipment on the 2000 model, may be used in the 1600. If it is installed in a 1967, or later model 1600 (designed to have a 5-speed as an option), you must purchase the 2000 drive shaft (Part. No. 37000-20100), rear engine mounting bracket (Part No. 11328-25503), rear engine support (Part No. 11312-25501) and two metric bolts (Part No. 1-14520).

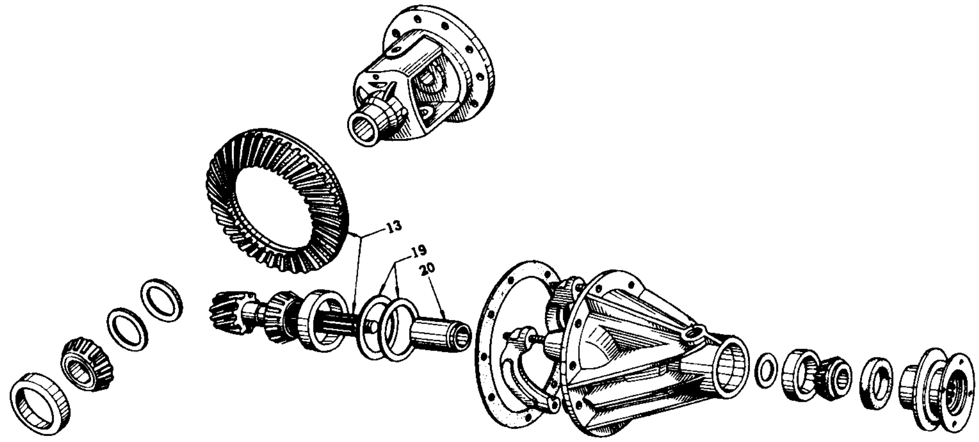
If the 5-speed is to be installed in a pre-1967 model 1600, purchase the drive shaft, rear engine mounting bracket and two metric bolts. You may use the existing rear engine support, but it must be relocated. This support rests between the "X" member of the frame and is secured with eight bolts. Merely move it down further between the frame rails — utilizing only the top 4 holes in the support to the bottom-most holes in the frame. The reason for lowering this unit in the frame is that the 5-speed stands taller than the original 4-speed and if it were not brought down, the engine and drive train would not be in plane.

The 5-speed transmission gear ratios are:

1st	2.957	4th	1.000
2nd	1.858	5th	0.852
3rd	1.311		

A few words of caution on the 5-speed: although this is an excellent unit, it will not stand too much abuse such as speed shifting and gear clashing. With the torque that the 2 litre or modified 1600 engines are putting out, fast shifting is not that necessary. Be kind, but firm, and the unit will serve you well.

It is recommended that the plastic cap on the breather hole be removed. Install a tube and route it to a catch can, mounted high in the engine compartment. Since this transmission does generate a great deal of pressure, you might encounter gear lube leakage around the main input shaft in the bell housing. If so, press out the steel guide sleeve and replace the rubber "O" ring with one of 1 7/8" inside diameter and a thickness of .125"-.150". An "O" ring of these measurements can be found in a transmission gasket kit for the pre-1961 Chevrolet Turbo-Glide. (Chevy Part No. 3760222).



1600 & 2000 REAR ENDS

The rear end ratios available are the same as listed for the 1500 model: 4.11, 4.38, 4.62 and 5.13. The stock unit in the 1600 is a 3.89; in the 2000, because of the 5-speed transmission, a 3.70.

With all these ratios available, plus tires ranging in height from the 5.00 to 6.00 series, and either the 4-speed or 5-speed transmission from which to choose, you should be able to reach maximum efficient horsepower on any length track. All these factors will give you endless combinations. For a starting point, you might consider some of these proven combinations:

MODIFIED 1600 ENGINE

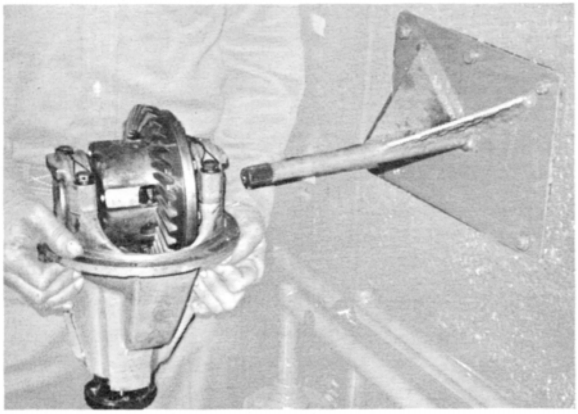
Course	Transmission	Tire	Ratio
Short	4-speed	5.50/9.20 5.00/8.30	5.13
Medium	4-speed	5.50/9.20	5.13
Medium	4-speed	5.00/8.30	4.62
Medium	5-speed	5.50/9.20 5.00/8.30	5.13
Long	4-speed	5.50/9.20 5.00/8.30	4.62
Long	5-speed	5.50/9.20 5.00/8.30	5.13

MODIFIED 2000 ENGINE

Course	Transmission	Tire	Ratio
Short	5-speed	5.50/9.20 5.00/8.30	5.13
Medium	5-speed	5.50/9.20	5.13
Medium	5-speed	5.00/8.30	4.62
Long	5-speed	5.50/9.20 5.00/8.30	4.62
Very Long	5-speed	5.50/9.20 5.00/8.30	4.38

Generally, with the 5-speed in a 1600, you can go anywhere with a 5.13. If the straights are exceptionally long, use a taller tire. If you have a 4-speed, you might need to use the 4.62 on the longer straights and the 5.13 on the tighter courses. It all depends on the degree of modification on the engine. For instance, a lightened flywheel will allow the engine to rev quicker coming out of a corner, thereby reaching the red line a shorter distance down the straight. For everyday street driving and weekend speed trial use, go with the 4.38.

With the majority of the courses in this country and a 5-speed in a fully modified 2000, you would generally use a 4.62.



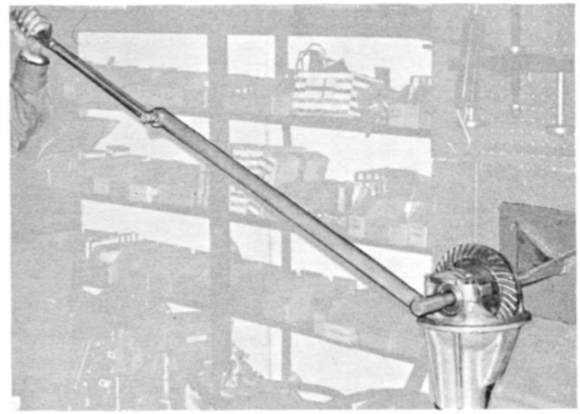


Figure 7

The following recommendations for reworking the factory unit entail special tools or quite a bit of innovating, but it all should be considered since it is not recommended that it be "locked" by welding or other stock car tricks. A fully locked unit induces a marked amount of understeer upon entering a corner, and exhibits extreme oversteer when power is applied upon exiting the corner.

The basic problem of the unit, under full racing conditions, is that it tends to slip too much. To overcome this, some pre-load must be built into the unit by installing shims. The desired pre-load is 170-230 ft. lbs. at the outer axle for the 1600 model, and 210-230 ft. lbs. for the 2000 to compensate for the additional torque of the bigger engine. These readings are the torque needed to turn the axle over when the completed unit is installed in the car.

Use the type of shim that goes under the pinion gear bearing cup in the stock 1600 carrier assembly. To get the desired pre-load, it takes .020"-.035" shims between the smaller half of the limited slip and the first shim on that side. That is, when the limited slip is apart, put the additional shim on top of the clutch pack on the ring gear side of the unit. Placed in this manner, the shims will be held stationary between the clutch that is keyed **into** the limited slip housing and the housing itself.

When checking to see that the limited slip has the proper pre-load, ensure that the ring gear is bolted to the limited slip housing and that the limited slip is placed in the rear end chuck with the bearing caps secured. With the caps in place and the side bearings installed, the total outside distance between the caps should be 198.35 mm to 198.50 mm. This can be measured with the Nissan Special Tool #DT-4638. See the Datsun Service Manual for operation.

If a tight fit is encountered when installing the completed unit into the rear axle housing, an undesired increased preload (over 230 ft. lbs.) will result. Therefore, the desired measurement between the caps should be closer to 198.35 mm rather than 198.50 mm.

You'll have to find a way to check the pre-load once everything is installed in the car. The Figure 7 photographs illustrate how the personnel at Bob Sharp Racing perform this task. The unit is mounted onto a stationary axle bolted to the wall, and as indicated in the second photo, a 4 ft. bar welded to a cut-down axle is employed to gain an accurate reading with a torque wrench. At the hub, using a 4 ft. bar with a 50 lb. spring scale, a reading of 200 ft. lbs. will be observed. Based on this, and using the formula of torque equals force multiplied by distance, you can apply the proper length tool to get the desired reading.

If you don't have the special tools, or don't wish to get involved with all the trial and error usually encountered, contact Bob Sharp Racing for assistance.

The various rear end ratios and some limited slip units are available from the Nissan Corporation. Use the following part numbers when ordering a complete rear end carrier with the ring and pinion already set-up. The first five digits is the carrier number, and the second five digits is the ring and pinion number.

MODEL SPL 310 (1500cc)

Ratio	Part Number
3.89	38300-10400
4.11	38300-09600
4.38	38300-08300
4.62	38300-04104
5.13	38300-04103

MODEL SPL 311 (1600cc)
MODEL SRL 311 (2000cc)

Ratio	Part Number
3.70	38300-25510
3.89	38300-14610
4.11	38300-16310
4.38	38300-13210
4.62	38300-17910
5.13	Not available as a complete unit

On the above 1600 and 2000cc units, the 3.70, 3.89 and the 4.11 carrier assemblies are aluminum. The 4.38 and 4.62 are steel.

All of the 1600 and 2000cc units include the limited slip already set-up in the carrier, but it still must be shimmed to gain the proper pre-load as discussed on Page 3-6.

If you wish to use either the 4.38, 4.62 or 5.13 ring and pinion gears in an aluminum carrier to reduce the unsprung weight, it will be necessary to place a .150" thick spacer behind the ring gear to gain the proper tooth mesh. Order the 4.11 aluminum carrier (Part No. 38300-16310) and the separate gears as listed below. The spacer is available from Bob Sharp Racing.

To order just the ring and pinion, use the following part numbers:

MODEL SPL 310 (1500cc)

Ratio	Part Number
3.89	38100-10400
4.11	38100-14301
4.38	38100-08300
4.62	38100-04101
5.13	38100-04100

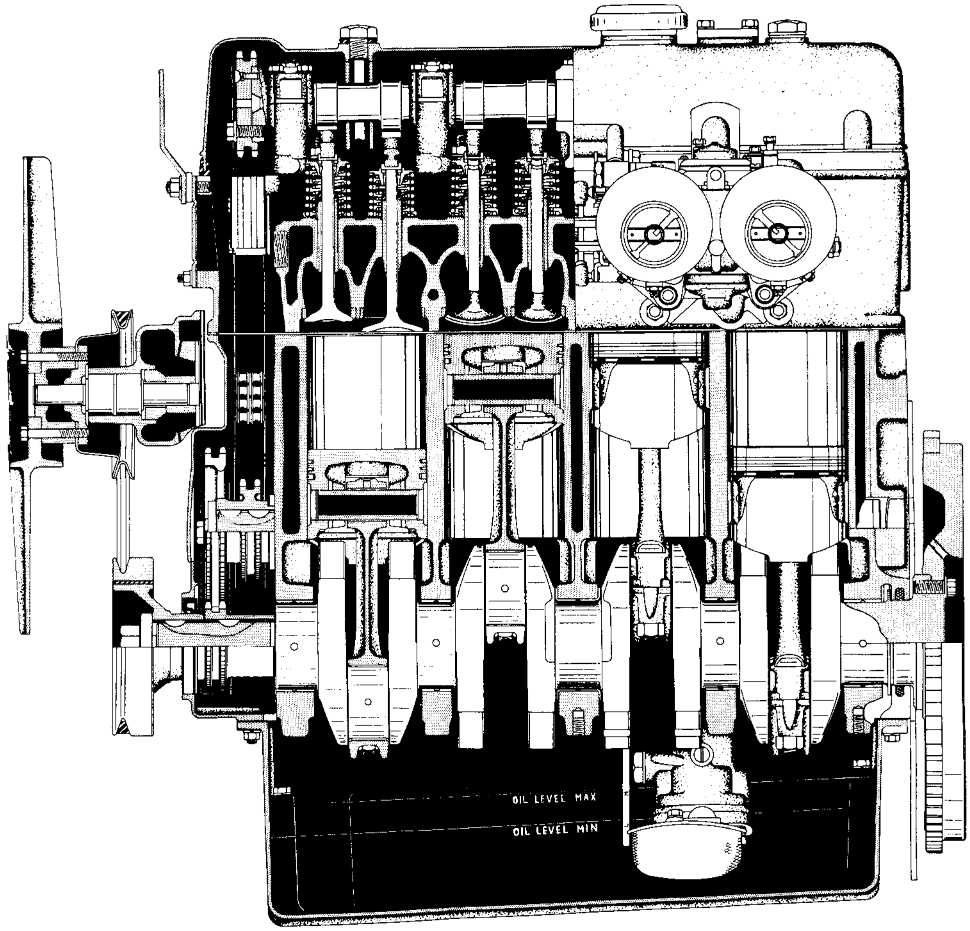
MODEL SPL 311 (1600cc)
MODEL SRL 311 (2000cc)

Ratio	Part Number
3.70	38100-77700
3.89	38100-61000
4.11	38100-61001
4.38	38100-13210
4.62	38100-36800
5.13	38100-37000

IMPORTANT: On the 1500 model, you must purchase the sedan carrier when installing a 4.38, 4.62 or 5.13 ring and pinion because of the pinion offset. Order carrier Part No. 38100-09600. If you are using a 4.11 ratio, just order the ring and pinion — as they will fit into your present carrier.

If you order new axles for your 1500, note whether your axles are threaded or tapered two inches behind the hub flange. The grease retaining seal for the outer axle bearing is secured, on some axles, by a nut and locking plate, and on others by just a press fit of the grease seal onto the axle. Specify which type you have when ordering.

On the following page is a convenient chart that will assist you in figuring track speeds. A grease pencil can be used on the acetate overlay. The value of the chart lies in the fact that, with so many gear ratios and tire sizes available, and either a 4- or 5-speed transmission, top speed can be changed easily from track-to-track. If you know what RPM you wish to use, you can figure what your speed will be by incorporating the rear end ratio and tire diameter.



CHAPTER IV-TWO LITRE ENGINE

GENERAL

The basic design of Nissan's 2000cc SOHC engine lends itself very well to racing conversion. For an in-line valve, overhead cam engine of this design, its stock horsepower is very impressive. There are no general restrictions as found with most production engines. That is, the valves are big enough to let the engine breath efficiently, there is ample carburetion, the combustion chamber shapes are basically good, and totally, the whole unit is strong. In fact, this engine is held in such high regard by so many well-known engine builders around the country, it is felt that a great many units will be used in modified cars running in Class B in SCCA competition.

Since the engine does have such a strong and efficient basic design, it is not too easy to realize great horsepower increases without quite a bit of work and expenditure.

To give you an idea, however, of just what can be obtained, the following general modifications, and their approximate costs, are listed in four stages. Stages I and II can be performed without removing the engine from the car or tying it up for more than one day. Stage III requires removing the engine and performing some machine work to the block and cylinder head. And, of course, Stage IV would be an all-out racing engine with great attention to detail.

STAGE I — From 135 to 150 HP. By merely converting the carburetion from SU-type to Solex, and adding the appropriate factory intake manifold and camshaft, 15 horsepower can be realized. This is available, as a kit through your Datsun dealer and costs approximately $275.00. You may also wish to add the higher capacity aluminum oil sump which sells for $37.00.

STAGE II — From 150 to 160 HP. This stage consists of Stage I plus installing special pistons (compression ratio increase from 9.6/1 to 12/1) and a free-flow exhaust manifold. The pistons are stock 1600cc engine units with about $50.00 worth of machining performed on them for clearance purposes. The manifold, $90.00, will only give you a few horsepower at this stage of tune, but has shown as much as nine more horsepower on full race engines where higher revs are used and there is more efficient induction and exhaust porting.

STAGE III — From 150 to 167 HP. This stage of tuning does not show the horsepower increase that would seem to be commensurate with the dollar expenditure required, but it is. This stage can be called the "insurance stage." That is, balancing your engine assembly won't give you any appreciable horsepower, just peace of mind. Also, at this stage, you should consider lightening the flywheel and "trueing" the block by machining. It is also advisable to perform various polishing and port-matching techniques. As mentioned, these changes don't show much in the way of horsepower increases on the dyno, but they allow your engine to rev faster and minimize the possibility of it coming apart once the higher revs are obtained. Here are the costs involved if you go from Stage I directly to Stage III.

Special oversized pistons	$100
Machine work to block	100
Machine work to flywheel	25
Balanced assembly	50
Camshaft Timing Kit	65
Exhaust manifold	90
Oil cooler kit	113
Machine work on head & valve job	75
Gaskets, bearings, etc.	50

STAGE IV — From 150 to 185 HP. You'll notice no mention, up to this point, has been made about a racier camshaft. The stock unit is that good. Again this bears out the uniqueness of this engine. But to gain maximum performance in a Stage IV engine, a great deal of attention in this area is in order. It has been found that it is not possible merely to drop a more radical camshaft in this engine and expect it to show horsepower readings of 185. Very sophisticated changes in the valve train must be made for top horsepower. This complete operation, including the camshaft, will cost in the neighborhood of $600. To this you might add $250 for a set of very exotic connecting rods and the cost of some Solex carb jets.

All the costs listed above for a good Stage III or IV engine might scare you a bit, but remember, this work will give you a car that is very competitive in Class C racing against cars that cost almost twice this amount in stock, showroom form!

Now that you have an idea of what's involved in the way of work, time and money, each step will be discussed in detail.

Generally, the work to be covered is written with full competition in mind. You may consider the various steps involved and perform any portion that best suits your needs and bank account.

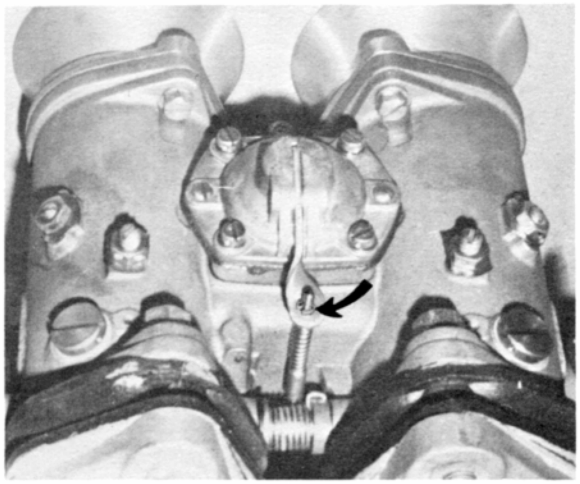


Figure 1

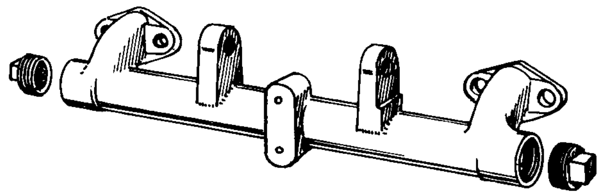


Figure 2

INDUCTION SYSTEM

Carburetors: Assuming that the car is equipped with the Solex carburetors and the factory camshaft is being used, the only modifications suggested are the additions of the air horns (velocity stacks) and an adjustment to the accelerator pump rod. It has been found, under racing conditions— or even in speed trial use — that the pumps tend to be a little too rich and the engine will bog down when full acceleration is applied upon exiting a corner. By re-setting the pump rod to the bottom-most hole (Figure 1) the diaphragm action will be shortened and the carbs will run leaner. Although no horsepower increases are apparent, on some engines it has aided the fuel flow throughout the rev range to bore the venturi from 37mm to 40mm.

On a Stage IV engine, where a more radical camshaft is employed, it is advisable to experiment with different main air and fuel jets. Anything between 1.75 - 1.90 mm for the fuel and 2.30 - 2.60 mm for the air jets has worked well — depending on the climate, engine horsepower and characteristics of the camshaft. If the engine can be tested with a fuel flow meter, in conjunction with dynomometer testing, the mixture can be tuned for maximum horsepower. Without a fuel flow meter, be careful not to run your test with too lean a mixture — as this might burn the tops of the pistons. With a fuel flow meter, you are looking for a specific fuel consumption of 0.49 to 0.53 lbs. per horsepower hour. For example, if the engine uses 85 lbs. per hour @ 6500 RPM and the horsepower at this RPM is reading 170 on your dyno, it will give you a specific fuel consumption of 0.50 lbs. This figure is obtained by dividing the absolute fuel consumption (85 lbs. per hour) by the horsepower (170).

Intake Manifold: The Solex carbs and intake manifold flow an adequate air/flow mixture for the cylinder head, so it is not necessary to open the ports. The only grinding recommendations would be to ensure that the rough castings in the ports be removed and a light polish be applied throughout. A mirror-finish is not needed. As long as you obtain a smooth surface, to the finger tolch, an efficient flow will ensue. Pay close attention, however, to the mating of the rubber insulators between the carbs and the manifold. Make sure they match properly. The same goes for the manifold-to-cylinder head ports and intake gasket.

In order to keep hot water out of the intake manifold, plug both ends of the water tube attached to the top of the manifold. Use pipe plugs for the job as illustrated in Figure 2.

EXHAUST SYSTEM

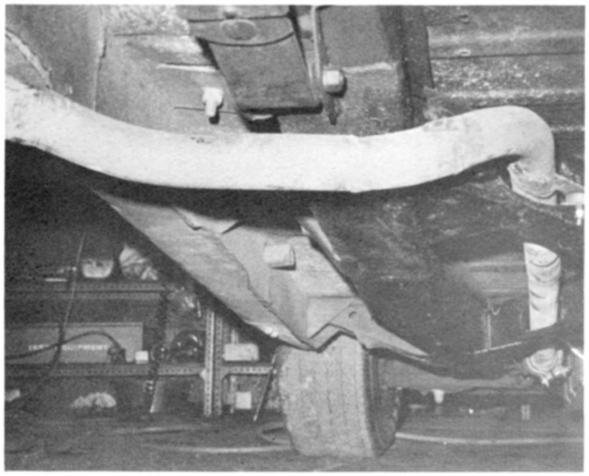


Figure 3

Exhaust Manifolds: The stock factory exhaust manifold is a very efficient unit. As with the intake manifold, it is only advisable to grind any welding slag that might be found in the port at the flange area and match the ports to the cylinder head. At the bottom of the manifold, there are no serious restrictions in the collection chamber. For racing, merely cut the stock exhaust pipe, behind the clamp and in front of the resonator box, and slip on a straight pipe. It is suggested that the straight pipe be routed in the same manner as the stock pipe, for ground clearance, and exited behind the second frame member (Figure 3) and out the side.

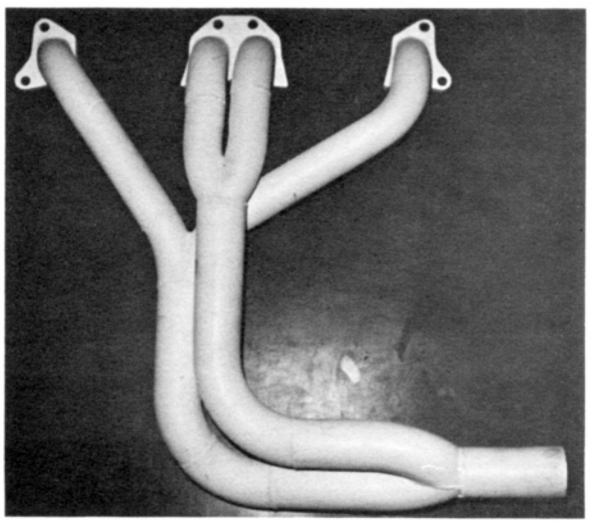


Figure 4

If a free-flow exhaust manifold, Figure 4, is used (up to nine horsepower increase on a full race engine), run a 1 ¾"-1 ⅞" ID exhaust pipe, slip-fitted and clamped, back through the first frame member. At this point, make another slip fit, without a clamp, to a second piece of pipe and exit it out the side behind the second frame member. The second slip fit is recommended in order to give the system enough flexibility to prevent cracking any welds. Any small exhaust leaks that might occur at this slip fit will not harm the efficiency of the system. Note, if a 1 ⅞" ID pipe is employed, it will be necessary to enlarge the holes in the frame members slightly by cutting with a torch.

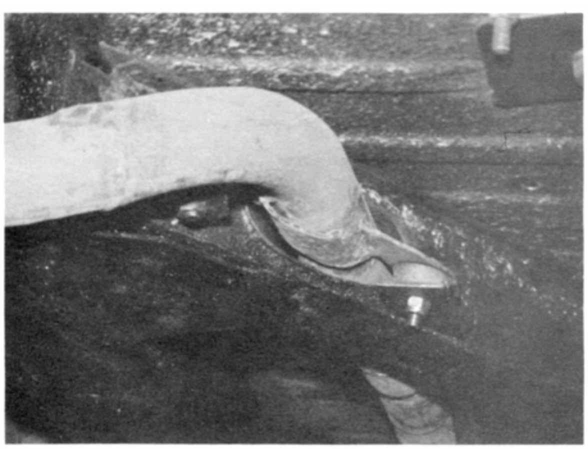


Figure 5

Figure 5 illustrates a practical and easy method of attaching the system to the car. The lower-half of the stock rear bracket can be welded to the exhaust pipe and bolted, with rubber insulators, to the existing mounting points. Unless the mounting bolts fail, it will be impossible for the pipe to fall off — even with the un-clamped slip joint incorporated into the system.

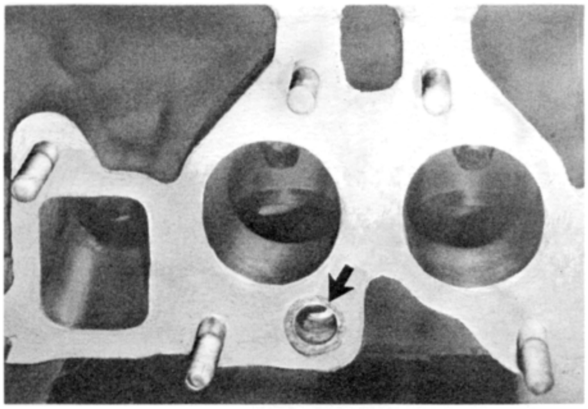


Figure 6

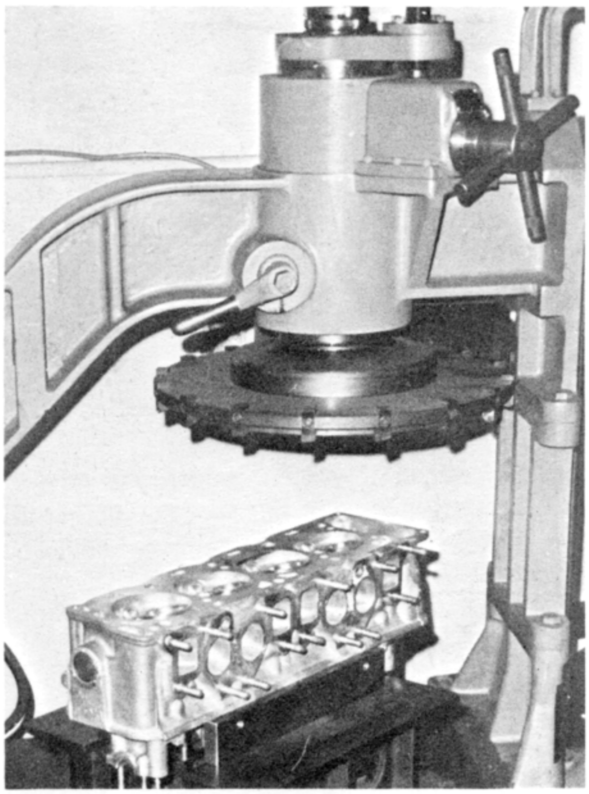


Figure 7

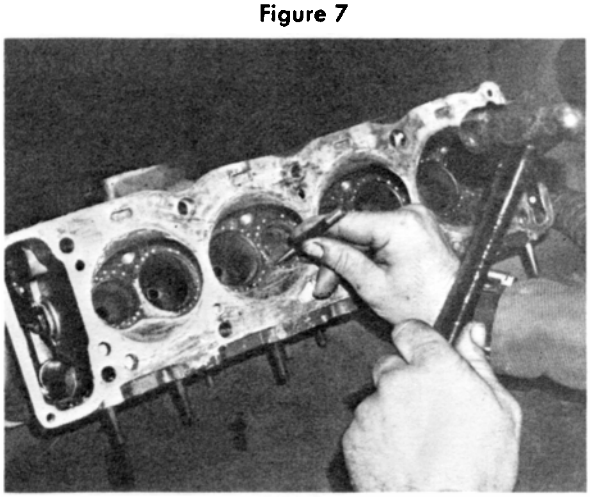


Figure 8

CYLINDER HEAD

The aluminum cylinder head on the SOHC engine is well designed. There are a minimum of casting marks that should be ground away in the efficient flowing ports and the combustion chamber shape lends itself well to a racing engine.

For any of the following work recommended on the head, it will not be necessary to remove the camshaft bearing pedestals. The caps must be removed, of course, to take out the camshaft, but not the pedestals. In fact, if they are removed, it is usually necessary to have the pedestals line bored for proper alignment — or at least a great deal of trial and error will be encountered when the camshaft is to be installed.

The first operation, after cleaning and de-carbonizing the unit, would be to grind the casting marks out of the intake and exhaust ports. It is not necessary to enlarge the ports, but merely polish to a finger-touch smoothness. As discussed with the intake and exhaust manifolds, match the ports of the head to the gasket and to the manifold ports.

Figure 6 shows the water passage to the intake manifold that must be tapped and blocked with a socket head bolt in order to keep the hot water out of the manifold. If you are taking the head to a machine shop for this operation, it might be a good time to have the surface checked for flatness. Any deviation should be less than .002". Unless some problem has been encountered, such as extreme overheating, it probably will check-out ok. The factory machine work on this engine is extremely good. But, if it must be trued, as much as .020" can be safely removed without upsetting the timing chain tolerances. Because the head surface flatness is critical and the fact that the unit is aluminum, a good milling machine, such as shown in Figure 7, should be used and each cut that is taken shouldn't be more than .004".

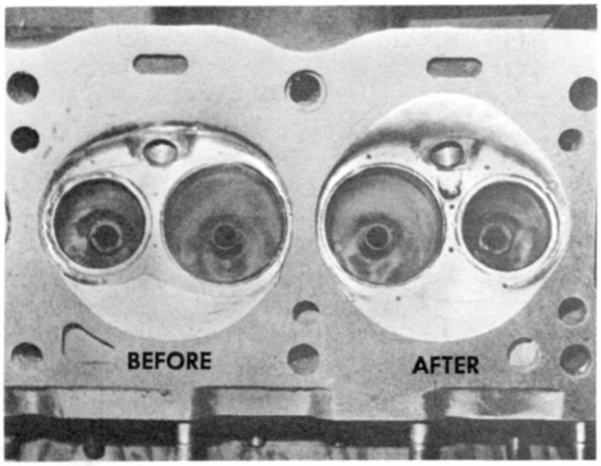


Figure 9

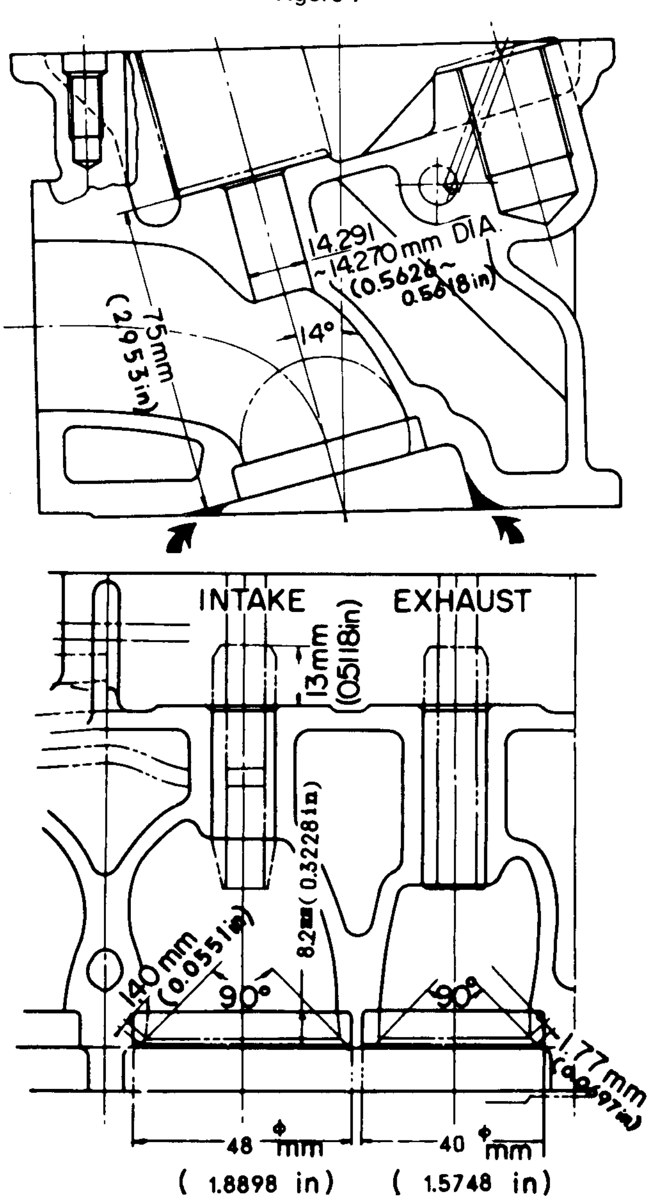


Figure 10

Next, direct your work to the combustion chambers. Figure 8 shows additional punch marks being made in the valve seats to ensure they stay in place. Before beginning any of the recommended grinding in the combustion chamber area, it might be worth your while to devise a way to protect the bronze intake valve seats. When grinding and polishing in the chamber, it is very easy to slip with the grinder and destroy the face of these seats. Later, when giving the unit a valve job, it will be very difficult to obtain a proper seal.

One method that proved totally adequate was to turn an old valve in a lathe and cut away the face to a point where the valve would cover the critical area of the seat when placed in its guide and be flush with the "floor" of the combustion chamber so as not to interfere with the grinding operation.

Once you have found a way to protect the valve seats, grind any rough castings in the chamber and radius the sharp edges around the spark plug hole. Next, unshroud the area around the valves as shown in the "before and after" photo, Figure 9. The top line drawing in Figure 10 is a sectional view of the cylinder head with the portion to be ground indicated by the shaded area. These drawings help alleviate any doubts you might have about grinding through a water passage. When grinding the radius around the edge of the combustion chamber, do not extend beyond the edge of the head gasket line.

As you progress with the grinding and polishing of the chamber, it is advisable to "cc" the area in order to ensure that not too much metal is removed. A stock chamber, accurately cc'ed, will hold 45.7cc's of fluid. The finished chamber should not be more than 48.1cc's in volume complete with lightened valves. And, all four chambers should be balanced or equal in volume. One method of cc'ing the area is to place a sturdy piece of plexiglass, with a ¼" hole, over the chamber and inject measured liquid from a syringe or burette.

The mathematics involved in figuring compression ratios on this engine are a little more difficult than most because of domed pistons whose edges don't come flush with the block surface at TDC, flycuts in the tops of the pistons, and notches on the edges of the cylinder bores. Following are listed various figures, ascertained from tests, that will give you all the reference points from which to work your own desired compression ratio:

Total unswept volume of stock combustion area	57.5cc's
Total swept volume of stock engine	495.5cc's

Notice that the total unswept volume is 57.5cc's and the aforementioned volume of the combustion chamber alone is 45.7cc's. It may be assumed from this that the head gasket area, plus the area above the stock piston that is below the block surface, makes up the 11.8cc difference (the flat top, stock pistons do not come flush with the block deck at TDC). Using the formula of unswept + swept volume, divided by the unswept volume, equals compression ratio, the above figures would be:

$$\frac{57.5 + 495.5}{57.5} = 9.6 \text{ c/r}$$

The addition of stock 1600cc engine .040″ oversized pistons give the following volumes:

Total unswept volume of combustion area	44.5cc
Total swept volume of over-bored engine	507.1cc

The unswept volume, in the above example, is reduced because the pistons are domed and protrude into the combustion chamber. The swept volume figure is increased because of the larger cylinder bore.

$$\frac{44.5 + 507.1}{44.5} = 12.4 \text{ c/r}$$

The area displaced by the domed piston is almost equal to the area of the head gasket plus the area above the piston — 13.0cc's compared to 11.8cc's, or a difference of 1.2cc's. The area of the head gasket alone, uncompressed, is 10.0cc's. This is based on a gasket thickness of .060″. The area of a compressed head gasket, at a thickness of .055″, is 9.2 cc's.

If the tops of the pistons are flycut .100″ for the intake valve and .125″ for the exhaust valve at a 14° angle; and if the edges of the block cylinder bores are given a radius and notched for valve clearances, the unswept volume will be increased by 1.5cc's, or a compression ratio of 12.0/1.

$$\frac{44.5 + 1.5 + 507.1}{46.0} = 12.0 \text{ c/r}$$

Another factor that will effect your final compression ratio will be the modifications recommended to the valves. Details of this work will be discussed in a later section. In order to ascertain what the effect of cutting .030″ off the face of the valve will have on your final compression ratio, "cc" the polished cylinder head first with the stock valves installed. After cutting the valves and performing a valve job (this too will increase your unswept volume as the valves will set deeper in their seats), perform the "cc" operation again to learn the amount of cc's gained.

In order to figure your final compression ratio, using the above basic figures, consider the following example: Using 44.5 cc's as the total unswept volume (based on stock .040″ oversized 1600 engine pistons and stock valves), and realizing that the stock cylinder head with stock valves contained 45.7cc's of volume before any polishing was performed, it is apparent that the portion of the domed piston that protrudes into the head has decreased the combusion chamber volume by 1.2cc's. This figure should be subtracted from the volume you have measured in the re-worked combustion chamber **with** the modified valves installed. To this new figure, add the volume gained by flycutting the tops of the pistons and notching the block for valve clearances (1.5cc's). This final figure will be your actual unswept volume. If you have followed the recommended grinding and polishing procedures in the combustion chambers and cut and re-seated the valves as outlined in a later section, the total volume of the chamber should be approximately 48.1cc's. Based on these figures, the compression ratio would be:

Combustion chamber volume	48.1cc
Displacement of domed piston	1.2
Volume gained by:	
flycutting pistons	0.7
notching block	0.8
Total swept volume	507.1

$$\frac{48.1 - 1.2 + 0.7 + 0.8 + 507.1}{48.4} = 11.5 \text{ c/r}$$

Any compression ratio from 11.3 to 12.5 is ok. A full race engine with a modified camshaft should run in the 11.3 to 12.0 range because of detonation that usually occurs with higher compression. It is more important to unshroud the valves for better breathing (increases unswept volume and lowers the compression ratio) than it is to run a compression ratio over 12.0/1. On the other hand, if the stock camshaft is to be retained, the compression ratio can run as high as 12.5/1 without difficulties.

If, after performing the combustion chamber grinding, piston flycutting and block notching, you find that your total unswept volume is more than 48.4cc's and your compression ratio is below the recommended 11.3 minimum, you may mill the cylinder head surface up to .020″ safely. Each .005″ cut taken off this surface will reduce the unswept volume by .81cc's. As a general rule with this engine, each cc equals approximately a ¼ point of compression.

Since the amount of metal removed from the tops of the pistons in the flycutting operation and the notching of the edge of the cylinder bores may differ in amounts from the figures given in the above example (0.7 and 0.8cc's respectively), it is recommended that the following procedure be followed to ascertain the exact compression ratio realized from your work:

Pistons: Before flycutting the tops of the pistons, weigh the unit. Perform the cutting operation (discussed in detail in a later section), and weigh again. Each 2.88 grams of aluminum removed is equal to one cc of increased unswept volume.

Block: The stock engine block already has slight valve clearance notches on the edges of the cylinder bores. If these notches are exaggerated for a higher lift camshaft and the edges of the bore given a radius for better fuel flow (discussed in detail in the engine block section), than an accurate "before and after" measurement must be performed to ascertain how much unswept volume is gained by this grinding. Working with the block in its stock condition, sculpture a piece of clay into the notch with the effect of filling in the depressed area. Remove the clay and drop it into a measured beaker of water and record the amount of liquid displaced. Perform the recommended grinding operation and clay the area again. Place this larger piece of clay in the beaker of water and note the additional displacement of fluid. The difference between this figure and the first figure recorded is the increase in unswept volume gained.

The final work recommended on the head would be a good valve job — using the stock valve seat angles of 45 degrees. Ensure that the valves make contact with the seats only at the outer edges and that a seat surface width of .055″ on the intakes and .070″ on the exhausts is maintained. If the seats are too wide, cut down the width by using a 15° angle cutting stone on the outside and a 75° angle cutting stone on the inner edge. Any good machine shop that has experience with high performance engines is familiar with this procedure.

ENGINE BLOCK

There is not much work needed on the block other than boring for oversized pistons and checking bore alignments of the crankshaft and jackshaft journals. As with the cylinder head, the factory machining is excellent. However, for a perfect assembly, the crankshaft line bore should be inspected and re-line bored to 2.6245″ diameter if found to be slightly off. This work cannot be performed by the average local machine shop that is not normally involved in critical tolerances, or doesn't have the modern equipment needed to do the job properly. For line boring, a Tobin Arp or Danish AMC machine, or their equivalent, should be employed. If you have no machine experience, it is highly recommended that you seek assistance in this area as poor machine shop work can destroy your engine and give you a finished product that will never perform satisfactorily. Consider all the races you have seen or read about where obviously quality marques have failed to finish because of overheating, blown head gaskets, or bearing failure. More times than not it can be traced to faulty machine work — not poor assembly procedures on the part of the mechanic. The jackshaft line bore, with the bearings installed, should be: 1st, 1.7887″-1.7892″; 2nd, 1.7274″-1.7287″; 3rd, 1.6228″-1.6233″.

The cylinder boring should be perfectly perpendicular to the crankshaft center line for best results. If the .040″ oversized 1600cc engine pistons are used, the bore should be 3.475″. This will give a piston/cylinder wall clearance of .004″.

After the final machining operation of truing the block surface, attention should be given to the valve clearance notches on the edges of the cylinder bores. If a camshaft with a lift of over .500″ is to be used, the existing notches should be exaggerated proportionately for proper valve clearance. Figure 11 illustrates this work. Remember, if any appreciable amount is removed from

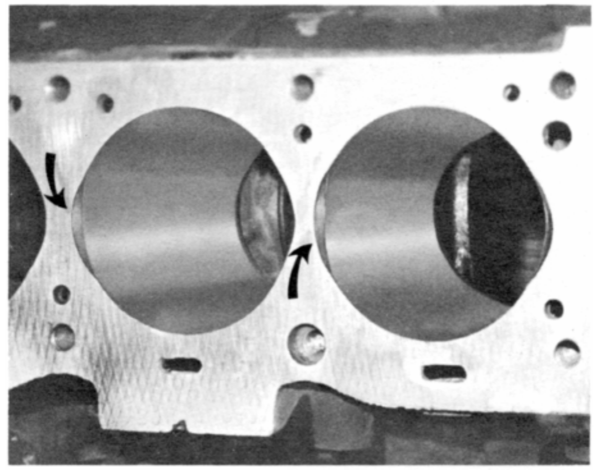


Figure 11

the block surface, it will effect your compression ratio and valve gear tolerances. Between the head and block milling, no more than a total of .020″ should be removed.

Before cleaning the block, you'll notice the impression of the cylinder head gasket left around the cylinder bores. Using this as a guide, you may wish to radius, or round off, the edge of the bore for better flow. This edge may be ground down into the cylinder bore to approximately 1/16″ to 3/32″ above the mark left on the wall by the top piston ring. The reason you don't wish to grind any deeper is that the 1600cc piston has its top ring land located closer to the piston top than the stock 2000cc unit. A close inspection of the sectional drawing of the U20 engine on Page 4-1 reveals the "shelf" or restriction to air/fuel flow found when the edge of the cylinder bore is left in stock form.

Of course, before beginning re-assembly, the block should be thoroughly cleaned and special attention given to digging out metal filings that tend to lodge in the oil passages and various crevices throughout the unit. If the block is to be cleaned by boiling, be sure the solution being used will not harm the white metal of the jackshaft bearings pressed into the block.

CRANKSHAFT

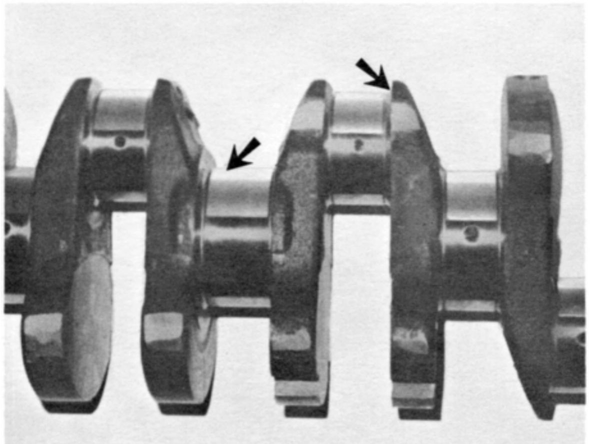


Figure 12

The five main bearing crankshaft is a strong unit and needs only to be magnafluxed for surface cracks in the journal area as part of preventative maintenance. Pay close attention to the fillets (Figure 12) and journal surfaces. Next, shot peen the fillets to remove any machine marks found in this recessed area. Check the crank for overall straightness. It should not run-out more than .0007" at the center main.

For adequate racing clearances on the journals, micro-polish the rod journals to within 2.0449" to 2.0451" diameter. This will give the connecting rod bearing a clearance of .0013" to .0026". The main journals should be polished to a diameter of 2.4782" — giving a bearing clearance of .002" to .003". All of the journals should be checked for roundness and be within .00015". It is not necessary to have the unit hardened, but it should be balanced independently of the other rotating parts of the engine.

After all machining operations are performed, remove the oil gallery plugs and thoroughly clean the passages. Replace the plugs and peen. Check for any burrs around the oil holes on the journal surfaces and chamfer if necessary to ensure that no edges are evident that might cause scoring of the bearing.

CONNECTING RODS

BEFORE

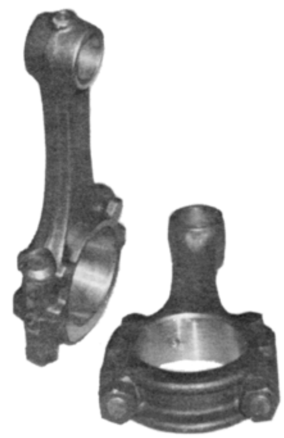


Figure 13

AFTER

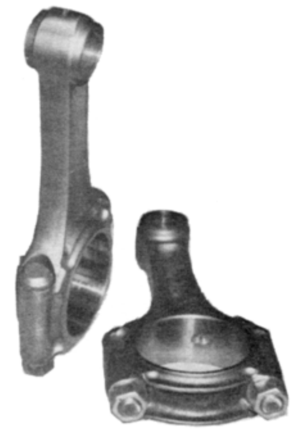


Figure 14

Using a stock connecting rod for racing is ok, but as mentioned at the beginning of this Chapter, as much as $250 can be spent to develop the rod to the ultimate. Most of the expense is involved in machine work as large amounts of metal can be removed accurately by this process. It is not just a light polishing job that can be accomplished with a hand grinder, as indicated by the "before and after" photos, Figures 13 and 14.

It is recommended that the big end of the connecting rod be line bored to a 2.1892" to 2.1897" diameter to accept a different bearing. The cap should be torqued to 65 ft. lbs. when performing this work.

A special Vandervell bearing, with a thicker shell, has been found to offer the best substitute for the racing version of the Datsun engine. This bearing (VP-663) is available from Bob Sharp Racing with a special oil groove machined into the surface for better lubrication. If this bearing is used, it will be necessary to machine a new locating notch in your connecting rods. This is a bearing centering notch and should be carefully made in order to prevent the bearing from moving laterally and making contact with the fillet radius on the rod journal of the crankshaft.

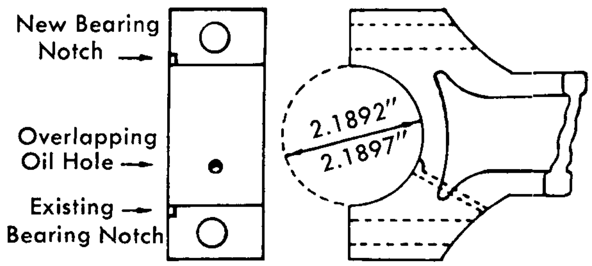


Figure 15

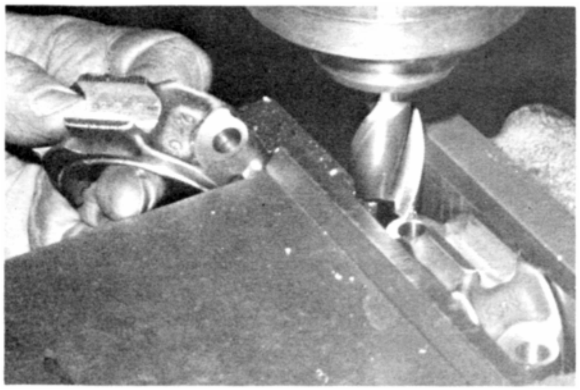


Figure 16

Bore the connecting rod to within .002" of the final desired diameter. For the final "clean-up" cuts, it is recommended that a Tobin Arp line boring machine or a Sunnen type hone with a mandrel large enough to accept the Datsun rod be used. Do not use a "Kwik-Way" type rod reconditioning machine which utilizes an abrasive cloth cylinder hone. It has been found that Datsun connecting rods sometimes have hard spots in the metal causing unever surfaces when cloth abrasives are used.

It is also necessary to match the oil hole in the face of the bearing with the oil passage in the connecting rod. This can be done by machining a small notch in the rod at the mouth of the oil passage, as shown in Figure 15.

Figure 16 shows the next machining operation that is recommended. The surface to which the nut makes contact can easily be burred or gouged when tightening or removing the nut. This leaves high spots on the surface. When the nut is re-tightened, it actually is only resting on these high spots and not giving a true torque reading. Therefore, these surfaces should be machined to ensure their flatness and the stock nuts replaced with a better grade material such as Premier Supertanium 7/16" x 20. Also, it has been found that the connecting rod bolt has a tendency to stretch when torqued to 65 ft. lbs. It is suggested that the bolts be measured in length before and after installation and be replaced if found to have stretched more than .001" over their natural length before use. There will be some stretch recorded usually in all eight of them, but if one is found to exceed the others in any great amount, replace it.

It has been found that some bolts pass their yield point, or elastic limit, at 50 ft. lbs. because of general metal failure. Therefore, torque the bolts carefully, watching the torque readings, and measure the length of the bolt after obtaining a 65 ft. lb. reading. **Note:** If Supertanium nuts are used, torque only to 55 ft. lbs. because of the plating on the nut. If you have any doubts about the limits of your bolts, have their hardness checked. You should obtain a Rockwell reading of 33, or above, on the "C" scale. Many bolts tested yielded only a reading of 25.

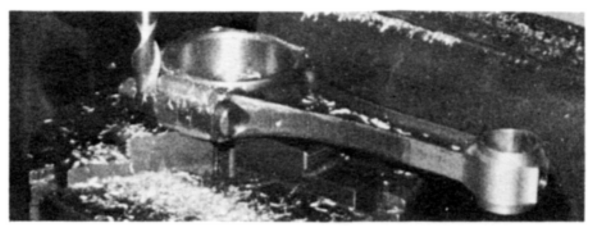


Figure 17

The Figure 17 photo indicates the amount of metal that can be removed by milling along the side of the bolt housing. Notice also how the small end of the rod has been lightened.

The piston wrist pin should have a slip fit in the rod bushing. Hone the bushing, if necessary, to gain .001" to .0015" clearance.

In summary, here is the order of work to be performed:

Check for straightness
Magnaflux
Remove excess metal
Shot peen
Bore and hone big end
Re-notch for special bearings
Machine nut surfaces
Fit wrist pin

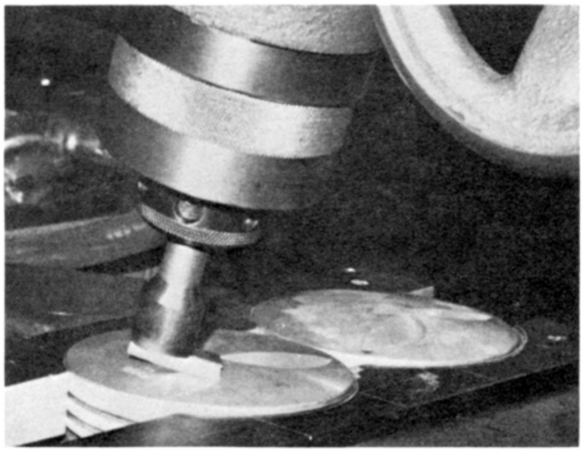


Figure 1 8

PISTONS

One of the easiest methods of gaining horsepower and increasing the compression ratio on the 2 litre engine is to install the factory stock .040" oversized 1600cc pistons from the SPL 311 model. Part No. 12010-14616.

If a camshaft, with a higher lift, is to be used, it will be necessary to flycut the tops of these pistons to ensure adequate clearance between the piston and valve. In order to locate the exact area to be cut, place the cylinder head on the block, without the valves installed, and bring the piston to TDC. Place a punch into the valve guide and mark the top of the piston. A good tool for this operation would be a used valve with the head cut off and the end ground to a point.

Once the area to be flycut has been determined, chuck the piston in a milling machine (Figure 18), at a 14° angle, and make the cut .050" larger diameter than the diameter of the face of the valve to be used. On the intake valves, a cut of .170" deep can be safely made. On the exhaust valves, .140". These cuts would be sufficient for camshafts with a high initial lift. Less is needed for a milder grind. The general rule is to have at least .080" clearance between the top of the piston and the valve face. This measurement can be made by "claying" the top of the piston after the camshaft has been installed.

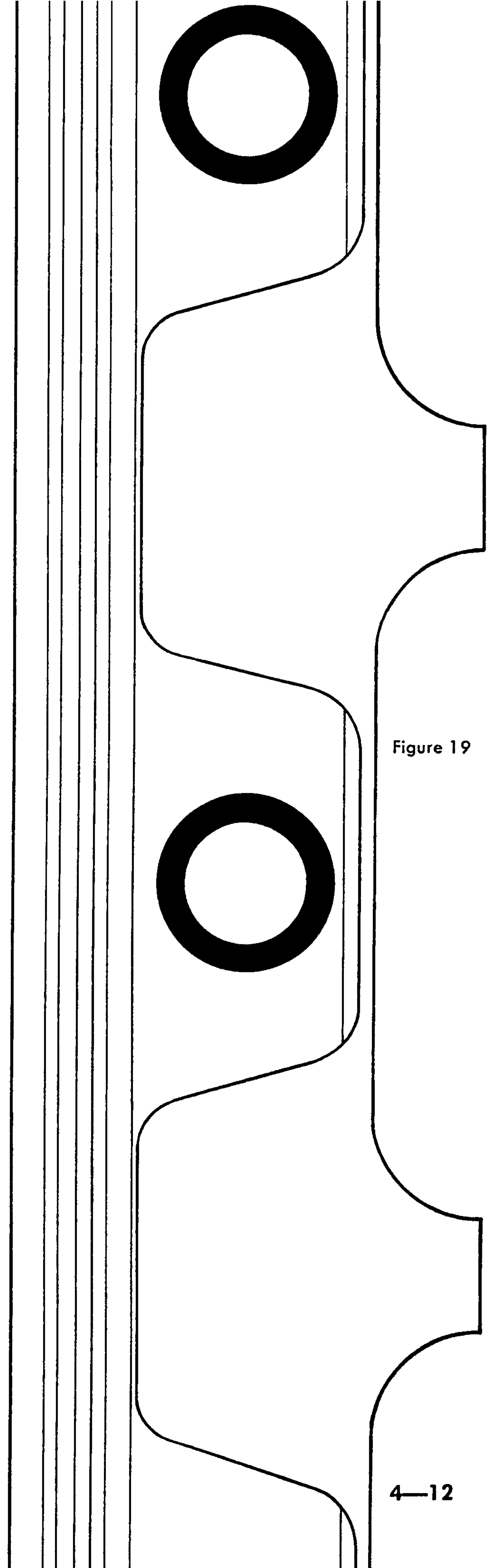


Figure 1 9

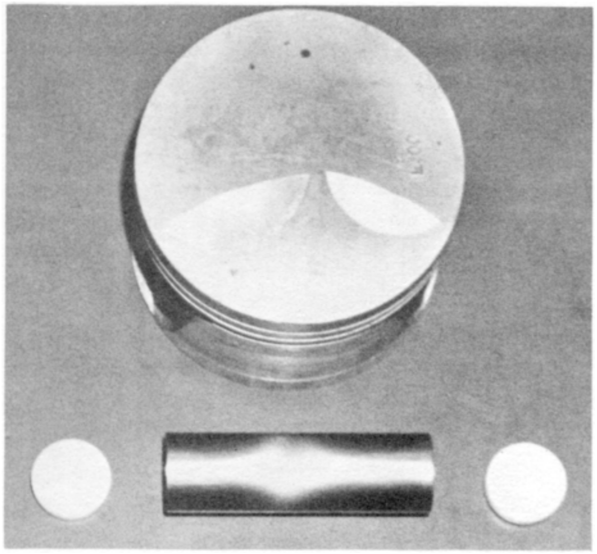


Figure 20

Another machining operation necessary is to cut the skirts of the 1600cc pistons in order to clear the crankshaft counter weights. For your convenience, merely trace or cut out the piston template, Figure 19. Wrap it around the piston, using the wrist pin holes as locating points, and scribe the line to be followed in cutting. Balance the pistons to each other by removing metal around the inside, just below the piston pin boss.

For a full race engine, it is advisable to have a slip fit, at room temperature, of the wrist pin to the piston. It will be necessary to hone the piston to gain this fit. Figure 20 shows the Teflon buttons that are used, in place of the wrist pin circlips, on the Bob Sharp engines. It has been found that the stock clips have a tendency to come out of their grooves allowing the wrist pin to destroy the cylinder walls. This is due to the higher revs of the racing engine and the loose fitting wrist pin sliding back and forth.

The 1600cc piston ring lands need no modifications, but it is advisable to replace the top piston ring as the stock unit is chrome plated and takes too long to seat. A suitable substitute would be the Perfect Circle cast iron ring number KTF 200. Order 3 7/16" plus .040" x 5/64".

VALVE TRAIN

As mentioned at the beginning of this Chapter, the most critical, and most expensive single operation, concerns the valve train and modified camshaft. Basically, the problem is that re-grinding an overhead camshaft has more adverse effect on other related parts than does a modified camshaft in a push rod engine. In an engine where the camshaft makes contact with a tappet, or follower, with a flat surface, the valve geometry can be easily ascertained and compensations made. Notice, in the exaggerted drawing of the overhead cam and its relation to the rocker arm, that the contact area of the rocker arm pad has a radius. In effect, as the ramp of the camlobe moves across this radius, the rocker arm ratio varies between 1.2/1 to 1.8/1 — depending on whether the lobe is making contact at the front or back of the pad. Another effect of a configuration such as this is the interaction of the ramps of the lobes and the radius of the pads. That is, at any given point, the valve lift is not necessarily equal to the cam lift, times the rocker arm ratio. These two surfaces, with their different radiuses, have a cumulative effect on the valve movement — or how much it opens. The valves open and close at a considerably different rate than if the camlobes were followed by a flat tappet. Because of this interplay, in theory, changing the radius of the rocker pad could have the same effect as re-grinding the camlobes of a push rod engine camshaft.

Before going into the details of the various work that should be performed, here are some of the other problems inherent in the U20 engine valve train that must be considered: On a re-ground racing camshaft, the base circle is smaller. This changes the angle of the rocker arm and its pad, and the lobe won't make contact at its normal point. Also, there is no way to advance or retard the camshaft, in relation to the crankshaft, on this engine. Another consideration is the fact that the pad surface on the rocker arm has only a flash chrome overlay which tends to wear very quickly under racing conditions. And finally, the entire valve train is quite heavy — making it more difficult to reach the high revs quickly and efficiently. The mere addition of stiffer valve springs does not help that much as they will decrease the longevity of the related parts — including the timing chains.

Even with the stock camshaft employed, close, periodical inspections should be made of the related parts for excessive wear. Also, it has been found that the timing chains will stretch, causing the engine to run retarded, and the timing chain tensioner is weak, allowing the chain to "slap" when the engine is started. So, even if you intend to use the stock camshaft, provisions should be made to rework the various items involved in the train to gain maximum performance and increased longevity.

Keeping all these basic problems in mind, each component of the assembly will be discussed in detail.

CAMSHAFT

Although the stock Solex camshaft has proven to be quite efficient at 6800 RPM, more horsepower and higher revs can be realized from a re-ground unit. The Solex cam has enough material to grind almost any profile that will give horsepower readings of 185 at 7200 RPM's. But, as discussed earlier, the grinding of a new lobe profile, that will work with the radius of the pad on the rocker arm, is quite intricate and demands a complete understanding of such engineering problems. Basically, by having a radiused rocker pad, the effect is a retarded opening process at the start, but an increased acceleration as the lobe approaches the middle of the pad. If the pad was flat, it would make contact sooner, but would not increase in rate as it progressed along the pad. And, as the lobe moves toward the other end of the pad, it causes the valve to close more quickly. These factors would cause an erratic valve action if the cam were to be ground in what would be considered a normal, good racing profile.

If you are grinding your own profile, keep the above problems in mind and have the unit re-hardened to the original factory specifications by the "Tuff-tride" process. After subjecting the camshaft to this hardening process, have it checked for straightness. If found to be bowed, it must be straightened by peening on the short side as opposed to placing it in a press as would be the case in straightening a crankshaft. Finally, clean the cam bearing journals with oil and a very fine emery cloth. Make sure all the oil holes are free of foreign matter and replace the plugs in the ends after removing for thorough cleaning.

ROCKER ARMS

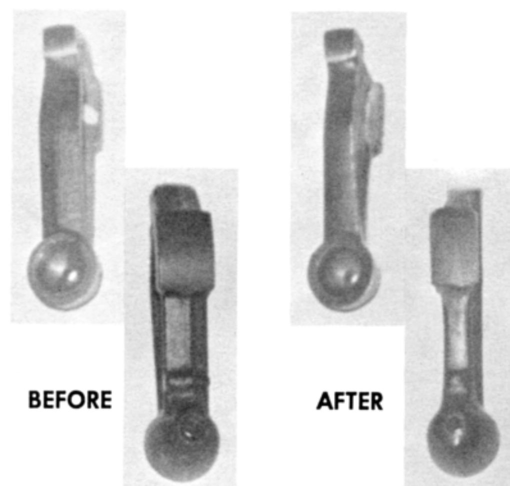


Figure 22

Figure 21 is an exaggerated drawing of the stock valve train geometry and the various changes that occur when a re-ground camshaft, with a smaller base circle, is installed. If you do not intend to lighten your rocker arms, as suggested in the "before and after" photo, Figure 22, but plan to install a racing camshaft, it will be necessary to file metal away from the under side of the shank of the rocker if modified collets are used (discussed later). This is to ensure adequate clearance be-

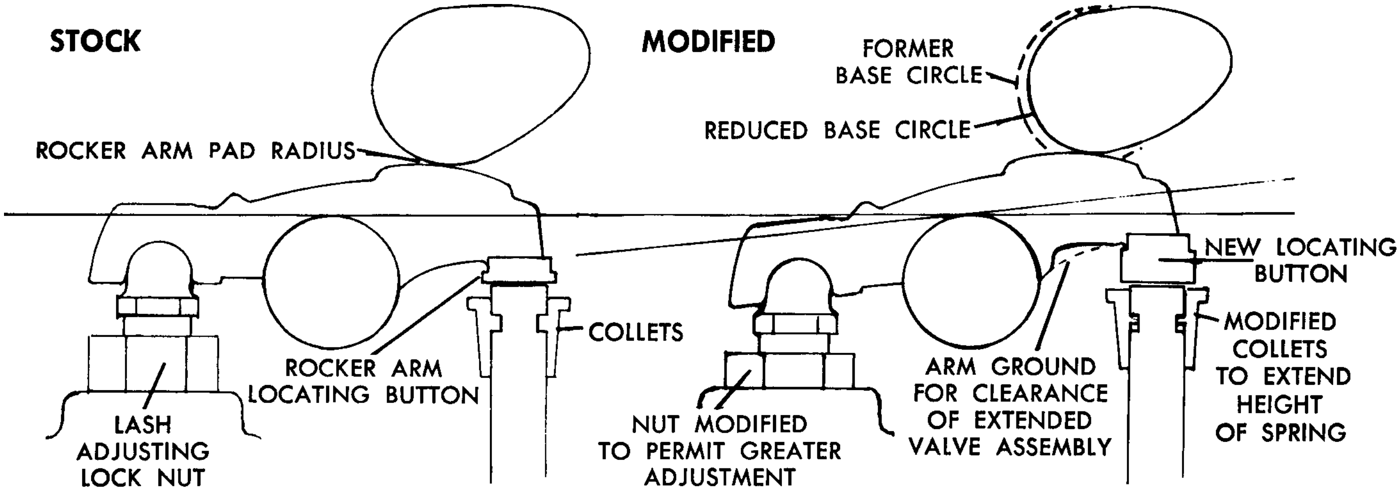


Figure 21

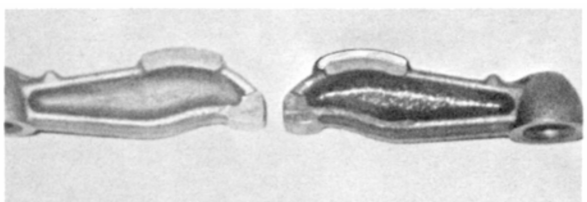


Figure 23

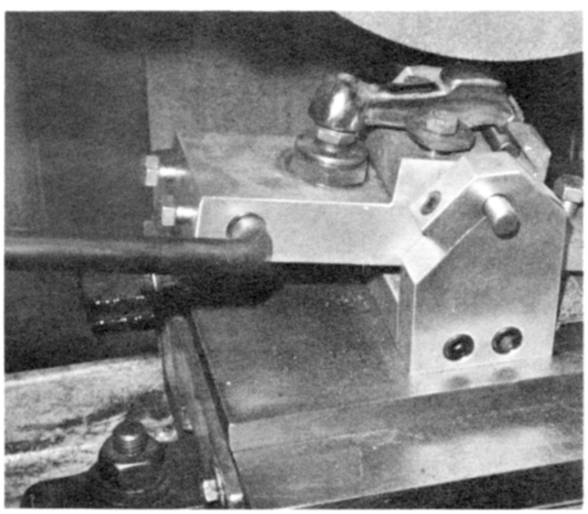


Figure 24

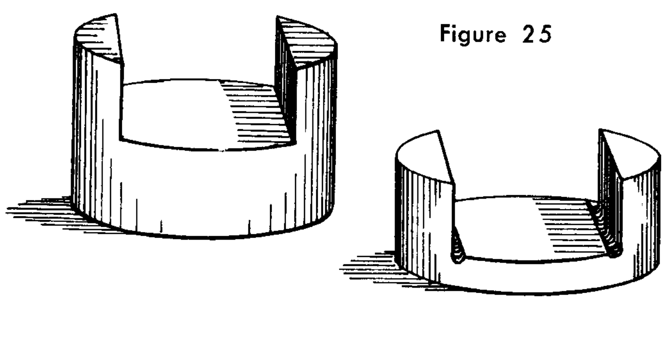


Figure 25

tween this surface and the edge of the valve spring retainer. Notice in Figure 23 the hard face overlay on the pad surface of the rocker arm. This is the type of rocker that came from the factory on the earlier models of the U20 engine. However, many have been imported with just a flash chrome overlay which will not hold under racing conditions. If yours are of the later type, it will be necessary to modify them for a racing camshaft. In fact, it is recommended even if you plan to use the stock Solex cam. As can be seen in Figure 24, a special fixture must be designed to re-grind the proper radius back into the pad after the hard face surface is applied. Not only is a special fixture required, but it is necessary to utilize the proper grinding wheel, on a surface grinder, that will remove the metal efficiently without glazing or disintegrating. When the lightening and re-grinding is completed, weigh each unit, at the valve end, to ensure that all are equal and radius any sharp edges by hand stoning.

ROCKER ARM LOCATING BUTTONS

The buttons, or guides, between the valve and the rocker arm must be custom made from centerless ground steel bar stock if a re-ground camshaft is installed. Figure 25 shows a stock and the thicker button that must be employed to bring the rocker arm back to its proper geometry once the base circle of the camshaft has been reduced by re-grinding. If the base circle has been reduced by .080", it has been found that a button that is .080" thick, in its cradle, will maintain the stock geometry. However, the stock geometry utilizes the rear portion of the rocker pad more than the front. To make greater use of the pad, the geometry should be changed slightly by making the button thicker than the amount cut off the camshaft base circle. Machine the new buttons to a cradle thickness of .025"-.040", plus the amount taken off the base circle, in order to utilize the full pad surface. To ensure that you have accomplished the recommended change, "blue" the surfaces and turn the engine over by hand, observing the area of the pad that is making contact with the camlobe.

It should be mentioned at this point that the lash adjusting lock nut must be machined to half its original thickness to give the adjusting nut more travel. This is needed as the angle of the rocker arm changes when used in conjunction with the racing cam with a smaller base circle.

As with the rocker arms, the machining of the buttons is very critical. Special fixtures will have to be made that will ensure that the two contact surfaces are perfectly parallel and the units will have to be hardened by heat treating before the final surface grinding.

VALVE SPRINGS

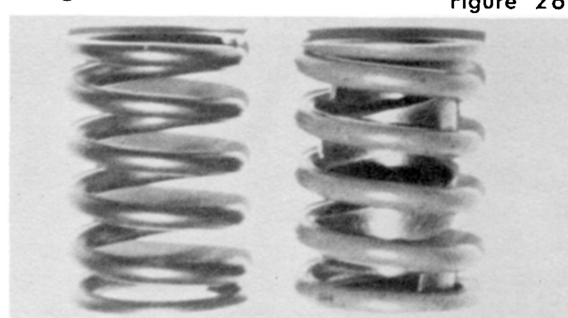
The stock valve springs are totally adequate for use with the Solex camshaft if the revs are held to 7000RPM's. If a racing cam is used and the revs will be exceeding 7000 RPM's, it will be necessary to install a spring strong enough to accelerate the mass of the valve train at such a rate that the rocker arm will stay on the camlobe at least 500 RPM above the desired red line.

Select a spring by plotting the valve action on the opening and closing ramps of the lobe. Choose the RPM's with which you'll be operating and calculate the acceleration. The acceleration is the second derivative of the lift vs. time graph of the lobe. In the lift vs. degree chart of the camlobe profile, the degrees will relate to time with a given RPM. The first derivative (velocity vs. time) can be found graphically by taking the slope of the lift vs. time curve. These figures are then plotted on another graph, as velocity vs. time, and the slope of this graph taken as acceleration vs. time.

The mass can be figured by weighing the components of the valve train (converted to a pound figure) and divided by the acceleration of gravity in ft. per sec.^{2} (32). The result will be in Newtons. Remember, the rocker arm should only be weighed at the end that rests on the valve, and only half the weight of the spring, assuming the coils are symmetrical, should be considered in your calculations.

The mass of the stock 2 litre valve train has been figured to be approximately .016 Newtons. Assuming the spring pressures will fall between 100-400 lbs., with a mass of .016 Newtons, the valve train will accelerate between 6,250 ft. per sec.^{2} and 25,000 ft. per sec.^{2}. If the cam profile has a higher acceleration for several degrees more than the valve spring can produce, then the valve will float. The force will vary with the lift of the cam and the acceleration rate ground into the lobe must not be a high value at a low lift.

Figure 26



The valve spring on the right in Figure 26 is the unit selected for use in the Bob Sharp Racing engines. The custom made outer spring is used in conjunction with the stock inner and a damper is employed between springs to reduce the harmonic vibrations. This combination gives a 20% increase in spring rate, with no increase in seat pressure, over the stock unit shown on the left in the photograph.

COLLETS

In order to keep from coil binding the above mentioned custom valve springs, when a camshaft with over .500" lift is used, it is necessary to use different valve stem locks, or collets. Select collets that will allow the valve spring retainer to sit .060" higher than the stock position when the valve is closed.

These collets, as well as all modified components of the valve train, are available from Bob Sharp Racing. Or, the collets may be purchased from a local parts house. Ask for valve stem locks, Allied part number U-117.

VALVE SPRING RETAINERS

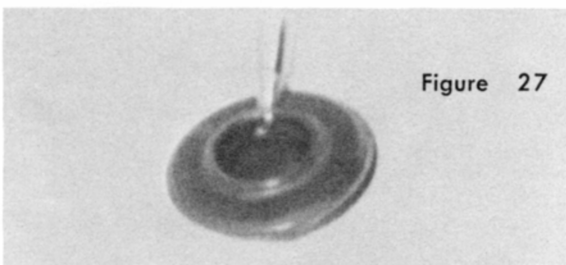


Figure 27

If the above mentioned modified collets and heavier valve springs are used, it will be necessary to perform some machine work on the retainers.

Figure 27 indicates the area inside the retainer that must be cut deeper to accommodate the special collets. In essence, by moving the collet up the valve stem .060", the top of the valve stem will sit deeper inside the retainer. This being the case, the button that the rocker arms rests in hits the inside edges of the retainer before it can make contact with the top of the valve. Therefore, the inside of the retainer should be turned deeper by .070" in a lathe.

VALVES

The stock valves on the U20 engine have proven to be adequate for racing. However, they can be lightened considerably by turning in a lathe. Metal can be removed from the face of all the valves, and from under the head on the exhaust valves, as shown in the "before and after" photo, Figure 28. Notice also that the stem has been machined approximately ½" up from the underside of the head. This is done not only for lightening, but also to "weaken" the valve. Should the timing chain break or jump a tooth on the sprocket, the valve will usually destroy the piston. With the stem cut down, you'll have a better chance of just bending the valve without doing too much damage to the piston.

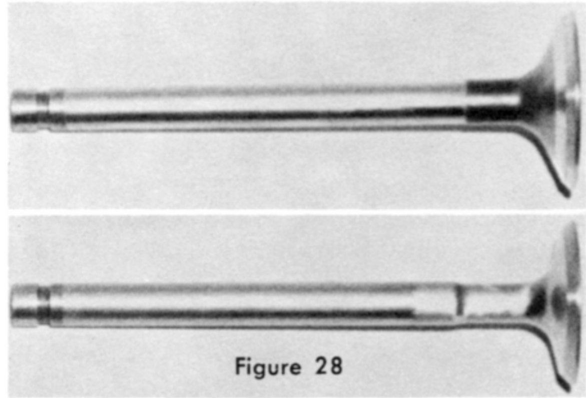


Figure 28

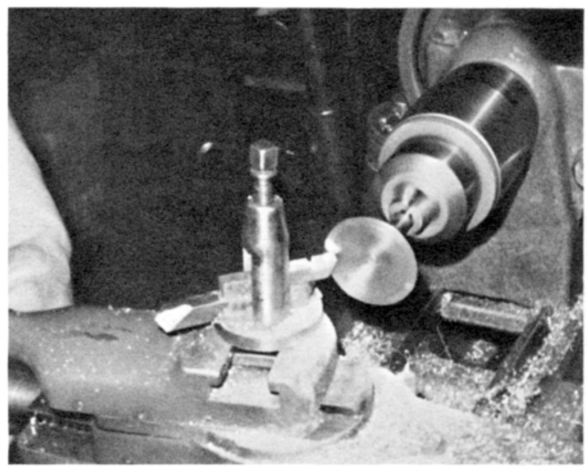


Figure 29

Figure 29 illustrates weight being removed from the face of a valve. On the intakes, the cut can be .020" deep; on the exhausts, .030" can be safely removed.

All machining marks left from the lightening operation should be polished out and any sharp edges radiused. The valve seat contact areas should then be trued in a valve facing machine to 45°, 30' to ensure that the contact surfaces are at the proper angle to the center line of the stem of the valve.

TIMING CHAINS

The stock timing chains seem to be adequate, however, they have broken under severe testing. A good replacement would be a Renold ⅜" pitch duplex chain, Part No. 114038. When ordering, specify the number of links desired. If the stock chains are retained, they should be replaced with every engine overhaul.

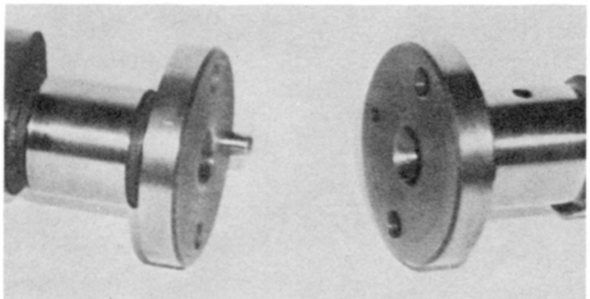


Figure 30

As mentioned earlier, this engine has no provisions for advancing or retarding the timing. Therefore, Bob Sharp Racing has developed a Timing Kit which includes offset bushings, as utilized in Chevy and Chrysler engines, a dowel pin (Figure 30), special drills for installation, and a remachined sprocket. By using the various bushings in the Kit, the camshaft can be advanced or retarded, in 2 degree increments, 30 degrees on either side of the stock timing. Re-timing is a must, even when utilizing the stock cam, as the chains wear and retard the timing from the factory specifications.

TIMING CHAIN TENSIONER

After the U20 engine has been sitting for awhile, the oil in the upper and lower tensioners will leak out. When this oil pressure is lost, the chains will "slap" when restarting. This can vary the valve timing critically — as much as 15 degrees. With the close valve/piston clearances caused by a higher lift camshaft, it is quite easy to make contact and bend the valves with the timing this far off.

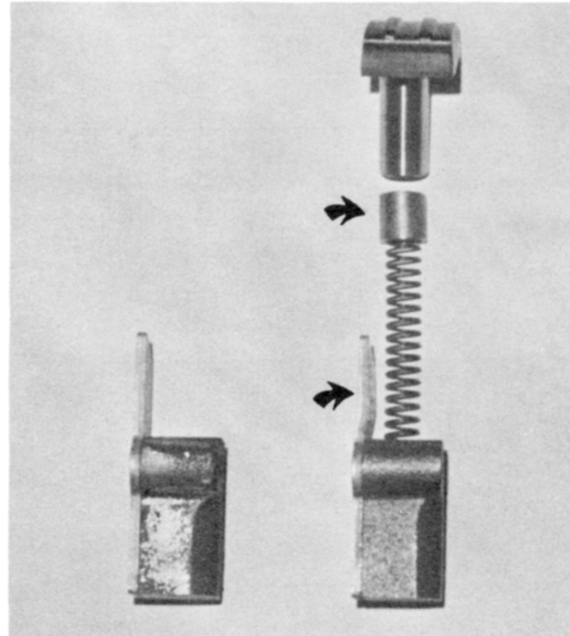


Figure 31

To alleviate this problem, place a metal ring, as shown in Figure 31, under the tensioner piston, that will seat on the bottom of the tensioner bore. The thickness of the ring should be such that it holds the chain tight. It will vary in thickness, depending on the wear of the chain. The more wear, the thicker the ring.

Figure 31 also shows how the body of the tensioner should be modified. Notice the bend made in the upper tensioner guide plate. Because of the clearance between the guide plate and the rubber pad, the pad can twist sideways and allow the chain to tear the rubber. Once the rubber is torn, it deteriorates rapidly. Therefore, bend the plate, as shown, to make closer contact with the pad.

JACKSHAFT

The jackshaft has been found to have cracks in the fillets between the nose and the first bearing journal. This is caused by the shearing action of the two sprockets on the nose of the shaft. Magnaflux the area and inspect the unite carefully. Figure 32 shows a 7/16" stud inserted into the shaft to

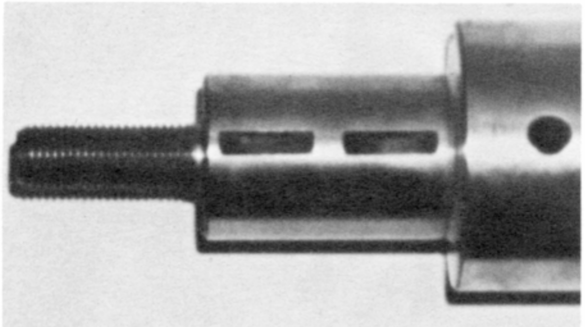


Figure 32

strengthen it. Have the shaft drilled and tapped back to the oil hole in the first journal and install the stud.

That covers the various machining operations and special parts purchases necessary to make the U20 a highly successful competitor. Assuming you have had good machine work performed and have secured all the special pieces, the assembly procedure will be covered next.

ASSEMBLY PROCEDURE

In order to facilitate this phase of the project, it will be assumed that you have the Nissan Service Manual for the U20 engine and 5-speed transmission. This is an excellent book and well worth having if you take engine building seriously. A copy may be ordered through Bob Sharp Racing or your local Datsun dealer.

This section will deal with the actual order of assembly, any special procedures or problems that might be encountered, and specifications that pertain to racing engines alone. In all cases, it may be assumed that the clearances and torque settings, as listed in the Nissan Manual, are to be used unless otherwise stated.

A thorough cleaning of all parts cannot be over emphasized. Since so many machining operations have been performed, you'll find filings in every corner and crevice. Also, sand, from the original casting, sometimes can be found built-up around the webbings in the block. Use a chisel or punch to remove these deposits. After ascertaining the availability of the various replacement oil gallery plugs throughout the engine, remove them and clean the passages with a detergent and hot water under air pressure. The final step in preparation would be to lightly spray paint the interior of the block to seal any small crevices and solidify any foreign particles that might have been missed.

Install the crankshaft, without the rear oil seal, to check the main bearing clearances. It is advisable to use blueing on the bearing surfaces as well as Plastigage. This will show any high spots left on the crank journals from the micro-polishing. As each bearing cap is torqued into place, rotate the crankshaft by hand, remove the cap and note the clearance recorded by the Plastigage. When satisfied that all the main bearings have adequate clearance, remove the crankshaft and install the rear oil seal. Be sure there is not too much sealing material standing above the cap-to-block surface. As the cap is torqued into place, the material will "mushroom" onto the surface and cause the cap to seat on an angle and wear the bearing unevenly. For racing, the main bearing cap bolts should be torqued to 80 ft. lbs.

NOTE: A word of caution is in order at this point. All torque specifications given in service manuals are "dry" figures. That is, the bolt, stud or nut, and their related mates are clean and free of any lubricant or sealer. It has been found that as much as 40% less torque should be applied to a recommended setting if the fastener is coated with oil or other lubricant. If the full torque is given to a bolt or nut that has any lubricant on it, there is a good chance that it will break or stip its threads — or at least be stretched beyond its elastic limit. Based on this, assemble your engine with a lithium based grease or heavy oil applied to the frictional surfaces, but try to keep the fasteners clean. And if a sealer, such as Loctite, is used be sure you know what percentage in decreased torque should be applied.

The main bearing cap bolts are different lengths. The intermediate caps, numbers 2 and 4, take the shorter bolts. These usually have a spot of white paint on their heads.

Assemble the pistons and connecting rods with the valve flycuts on the right side. Before placing the rings on the pistons, insert them in the bores and check the butt gap of each with a feeler gauge. The top rings should have .010"-.015" clearance. The second and third rings should have .006"-.012" clearance. When placing the pistons and rods into the bores, make sure the numbers stamped into the sides of the rods are away from the jackshaft.

Use plenty of lubricant on the cylinder walls and the pistons. As with the main bearings, Plastigage and blue the rod bearings before the final assembly.

The stock oil pump produces approximately 50 lbs. of pressure and is adequate for a full race engine. Disassemble the unit and check for any foreign particles or burrs that might impede the pump's operation. Prime the unit with heavy oil and install. Notice the position of its gasket. If placed on backwards, the oil passages will be blacked. Use Loc-tite on the mounting nuts.

Next, install the jackshaft, using Loc-tite on the retaining plate screws. Assemble the sprockets, timing chains, chain guides and lower tensioner as outlined in the Service Manual. Before placing the front cover on the block, make sure the oil slinger is on the crankshaft, over the sprocket. Use all new gaskets on the cover, with gasket sealer, as oil leaks develop easily in this area.

Before bolting the oil pan to the block, check the baffle for tightness. There is a cardboard type pan gasket available (Part no. 11121-12210) that can be used many times. The stock gasket is cork and must be replaced each time the pan is removed.

For the initial clearance checks of the pistons, install the cylinder head on the block **without** the head gasket. If the pistons raise the head more than .010", when the crankshaft is rotated by hand, additional clearance work will be necessary.

Install the head gasket, **without** gasket sealer, and torque the head as per the Shop Manual. Insert the number one intake rocker in its place and time the camshaft as per the cam grinder's specifications. The following operation is performed to ascertain the valve-to-piston and valve-to-block clearances. To illustrate the importance of this work, being one tooth off in the cam timing will allow the valve to hit the top of the piston. Find TDC of number one piston. One method would be to remove the porcelain and electrode from an old spark plug and use the case as a guide for a rod inserted into number one cylinder. Turning the crankshaft by hand, bring the piston up until it touches the rod. Note this position on the degree wheel attached to the crankshaft, or compare it to the marks on the crankshaft damper made by the factory. Rotate the engine in the opposite direction, a full revolution, until the piston comes up again and touches the rod in the spark plug hole. Note this reading on the degree wheel. The two marks noted will differ. Therefore, the midpoint of the two will be TDC. If the TDC mark on the damper, made by the factory, is accurate, have a machine shop scribe additional marks the full 360 degrees. The damper can then be used as a degree wheel.

The critical area to watch for intake valve clearance is from TDC to 15 degrees after TDC — depending on the cam grind. With a dial indicator, as shown in Figure 33, check the clearance between the valve and the piston by prying the rocker down with a lever and noting the travel from the starting point to the point where the valve hits the piston. Do this in 2 degree increments from TDC to 15 degrees after TDC. It should always maintain at least .080" clearance.

Follow the same procedure on the number one exhaust valve. The critical area to

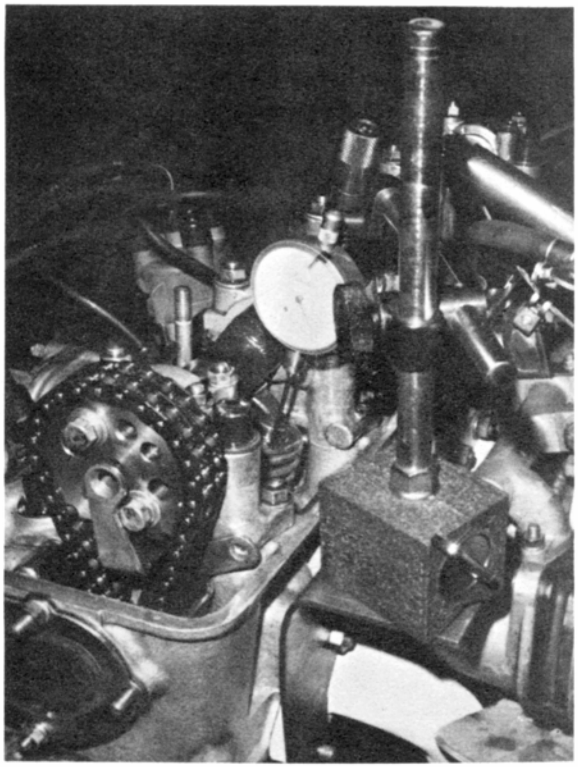


Figure 33

watch would be the 15 degrees **before** TDC, which would be the closing of the exhaust valve.

As mentioned earlier, the U20 engine has no provision for advancing or retarding the cam timing. Therefore, a kit has been developed with different offset bushings which allow the timing to be moved, in 2 degree increments, 30 degrees on either side of the stock timing. Using the various bushings in the kit, run through the above procedure, recording the various clearances each bushing allows. The reason for this work is that later, when the engine is installed on a dyno, various timing changes can be tried for maximum horsepower readings without the fear of clearances falling below the minimum of .080". And the reason dyno testing is highly recommended is that with a two-chain timing design, there is a great deal of slack and movement as the chains stretch and wear. Therefore, the readings at 7000 RPM's might be quite different from what was expected from a static, or set-up, reading. In all cases, make provisions to hold the chains tight while running through the checking procedures.

At this point check the rocker pad/cam lobe contact area by blueing the surfaces. If the lobe is making contact too far back on the pad, install a thicker button. You might find the contact area to be different on each rocker because of the valve job performed with different seat depths. If this is the case, use different thickness buttons with each rocker to ensure that all lobes and pads are making contact in the same area. A selection of buttons is available from Bob Sharp Racing.

For the final clearance check, remove the cylinder head and place clay in the notches on the edges of the cylinder bores. This is to ensure that you have adequate clearance for the valves in this area. Also place clay on the tops of the pistons as a double-check for clearance in the combustion chamber. Once you are satisfied that all the clearances are adequate, clean the area and replace the head using a gasket sealer.

Install the alternator, using double nuts and Loc-tite as the unit has a tendancy to vibrate loose.

Static time the distributor with the rotor pointing to the number one ignition wire when the points are just opening. Ensure that this opening action is taking place at 15-20 degrees before TDC.

The water pump needs no alterations other than plugging the top heater hose outlet in the housing. Cut two blades from the plastic fan and use the stock fan belt. Other than removing the fan shroud, the 8.5 litre radiator needs no modifications. It is advisable, however, to replace the factory hoses with a suitable substitute and wrap with electrical tape.

The oil cooler should be mounted in front of the radiator, on top of the frame member and its hoses bracketed or protected from vibration damage. The stock gas lines are used and maintained in their factory installed positions.

TUNING AND BREAK-IN

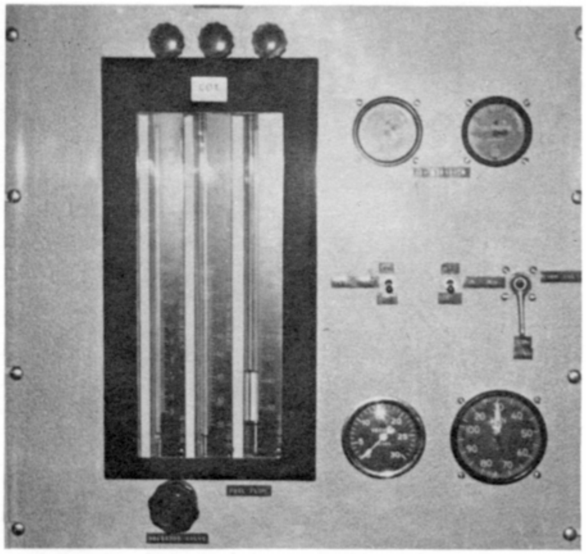


Figure 34

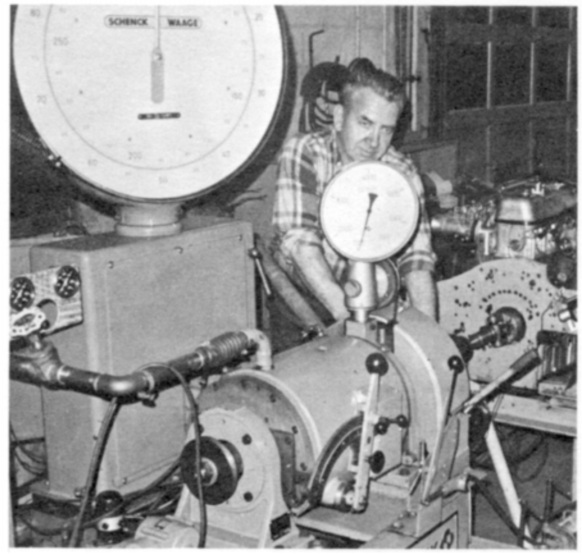


Figure 35

The engine should be tuned and run-in on a dynamometer with the highest commercial octane fuel available. Static set the distributor 15 degrees before TDC to get the engine started and lash the valves to the cam grinder's specifications. Valve lash will increase approximately .003″ from cold to hot readings. Use stock main air correction jets (2.40mm) and main fuel jets (1.80mm) in the initial runs. For cold starting work the accelerator pumps by hand and give full choke without throttle. Consult the Shop Manual for further information on the characteristics of the Solex carburetor. The initial spark plug should be a warm, extended tip unit such as the Champion N65Y.

If a modified camshaft is used, with stiffer valve springs, do not run the engine below 2500-3000 RPM's for the first 30 minutes. To let the engine idle or run below 2500 RPM's will wear the cam lobes excessively. Although this may seem strenuous on a new engine, it is more important to save the valve train than it is to be concerned about the bearings. During the initial run-in period, hold the revs below 5000 RPM's and check the timing at 3500. It should advance to approximately 40 degrees before TDC.

After the warm-up period, re-torque the cylinder head and check the camshaft and rocker pads for excessive wear. If all is in order, make a few power runs, changing to colder spark plugs such as N60, N60Y, N57R, N81R or N83R. An experienced dynamometer operator should be employed — not just to achieve maximum horsepower, but to "read" the spark plugs and ascertain the fuel/air flow (Figure 34). The specific fuel consumption should be in the area of .49 to .53 lbs. per HP hour. The U20 modified engine requires quite a bit of ignition timing. As much as 55 degrees total advance has worked well with the Bob Sharp Racing cam and the "R" series spark plugs. With a "Y" series plug, or standard tip plug like the N60, usually less advance is needed. Check the distributor advance, in small increments, up to 5000 RPM's.

The final work on the dyno would be to experiment with advancing or retarding the camshaft by using the different offset bushings. It has been found that a 2 degree change can effect the horsepower by as much as five points.

Before installing the engine in the car, remove the oil pan and check the bearings. If any specific problems are encountered, or any additional information is needed, you are more than welcome to contact Bob Sharp Racing for assistance.

Given: Transmission ratio, Scale **F**; Rear end ratio, Scale **D**; RPM, Scale **G**; Tire diameter (in inches) Scale **B**.
Find: Overall gear ratio, Scale **E**; Speed, Scale **A**.

Procedure:

1. Connect known points on Transmission, Scale **F** and Rear end, Scale **D**. Mark point at Overall Gear Ratio, Scale **E**.
2. Connect known points on Tire diameter, Scale **B** and RPM, Scale **G**. Mark point on Datum line, Scale **C**.
3. Connect two marked points (Scales **C** and **E**) and extend line through Speed, Scale **A**.